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PERIODICAL ROOM
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EVERY BUILDER *who visits the show will leave with a more thorough understanding of his own individual problems and better equipped to secure his share of the* 1916 *business.*

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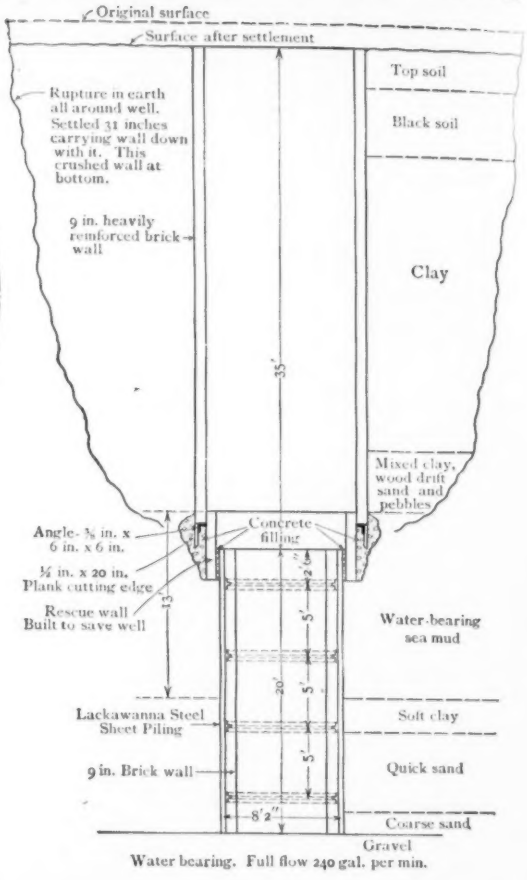
Center Line of Lackawanna Steel Sheet Piling
Center Line of Bolts
2 Angles 3½" x 3½" x ½"
Plate ⅝" x 4" x 1'9" lg.
2 Angles 3½" x 3½" x ½"
¾" Bolts
½" Washer
Splice plate
½" x 4" - 1'9" long
Radius = 4'4"
Radius = 5'5½"
Plate ⅝" x 4" x 1'9" lg.
⅝" Bolt



Water bearing. Full flow 240 gal. per min.

The City of Indianola, Ia. contracted for a 12-foot brick-walled well to be sunk 55 feet to gravel strata. The brick wall was started on a wooden cutting edge and dropped with the excavation until at a depth of 30 feet sea mud ran in as fast as the soil was removed. The earth surrounding the well then ruptured and its surface sank 31 inches. The wall stuck and its lower end was injured. All attempts to get past the mud with wooden sheeting failed and it was feared that the well could never be completed.

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The joint between the brick and sheet piling wall was made solid by a rescue wall and a filling of concrete. On complete excavation the well proved capable of supplying all needed water and is now thoroughly satisfactory.

Lackawanna Steel Sheet Piling has brought success on many other works that appeared hopeless, so you can profitably send for and read our book of engineering information on this subject. Sent free to managing and contracting engineers.

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Two Early Suspension Bridges Just Taken Down

The new long-span steel arch over Reversible Falls, at St. John, N. B., replaces a suspension bridge of 628-ft. span immediately alongside. This suspension bridge, built in 1852 and removed within the past autumn, is one of the monuments of early bridge construction in America.

A second suspension bridge, of nearly the same age, located 210 mi. farther up the St. John River, was also replaced by a modern span during 1915. Descriptions of the two old bridges are fortunately available, through the care of A. R. Wetmore, Provincial Engineer of New Brunswick.

The bridge at Reversible Falls, a substantial wagon bridge, was designed by Edward Serrell in 1852 and built under his supervision by William K. Reynolds. The following details concerning it are quoted direct, for the most part, from a specification issued for the contract of removal.

The clear span between end posts is 583 ft. 3 in., but the span of the cables between towers is 628 ft. The roadway is 20 ft. 9 in. wide in the clear, and it consists of yellow-pine floorbeams 4½x14 in., spaced 21¾ in. apart, which are covered with three layers of planking. Two substantial Howe trusses, 7 ft. high, for stiffening the floor and also serving as side railings, are spaced 21 ft. 4 in. and rest just outside the wheel guards, on top of the floorbeams, to which they are firmly connected by means of the truss rods going through the floorbeams and through special 4x6-in. bottom chords which run lengthwise under the floorbeams. The width of the floor planking between the wheel guards is 19 ft. 6 in.

This whole wooden superstructure is suspended from ten cables, five on each side, hanging side by side parallel with each other, by means of ⅞x3⅜-in. flat iron suspenders, spaced 43½ in. As the floorbeams are spaced 21¾ in., it follows that only every other floorbeam is suspended from the cable, while the intermediate floorbeam rests on the special lower bottom chord of the truss and in addition is suspended from the guard rails by ⅝-in. bolts. The suspenders are secured to the floorbeams by means of 1½x½-in. iron straps with ⅝-in. bolts and run alternately to the different cables, to which they are fastened with 2¾x¼-in. cable bands and ⅝-in. bolts. Every 36¼ ft., however, which is equal to every tenth suspender or every fifth truss panel, there is a heavier suspender consisting of 1⅛-in. round iron, which runs from the floorbeam to the center cable and pulls simultaneously on all five cables by means of a ⅞-in U-bolt that goes through a 2½x½-in. oblong cable band encircling all five cables, which are kept in their relative positions by wooden separators.

All floorbeams suspended by 1⅛-in. rods are about 4 ft. longer than the other beams, for the purpose of bracing the top chords of the trusses against the ends of the floorbeams with 5x5-in. braces. These braces keep the trusses in line and prevent buckling of the top chords.

THE OLD ST. JOHN SUSPENSION BRIDGE, WITH RAILWAY CANTILEVER BEHIND IT

A new steel arch highway bridge has been built between suspension bridge and cantilever, and the suspension bridge has been taken down

For guarding the bridge against lateral oscillations it was provided with two systems of wind bracing—one, under floor, consisting of 5x6-in. timber bolted to the floorbeams and running diagonally from the first to the fifth, then to the tenth, etc., truss panel; and another, overhead, consisting of 2-in. wire strands and running diagonally from the cable saddles to the cable bands which correspond with the first, fifth, tenth, etc., truss panel. The side thrust of these wire diagonals is taken up by struts which, in form of Howe trusses, connect the two systems of cables at the tenth and twentieth truss panels, where they are secured to upright wooden posts which run, in an inclined direction parallel with the suspender, from the floorbeam to the cables. In addition to the two systems of wind bracing, as described, there are a number of side guys which from the rock at each end of the bridge run to various points of the floor.

NEW AND OLD BRIDGES ACROSS ST. JOHN RIVER GORGE AT GRAND FALLS, N. B.
Old suspension bridge built 1855, removed 1915; span 209 ft. 9 in. New bridge erected by cantilever method in 1915; main span 279 ft. 10 in.

Each cable is composed of 290 straight, parallel No. 9 wires, forming a strand of 2¾-in. diameter before being wrapped, but of 3-in. diameter after having been served with a close wrapping of No. 12 wire. The cables rest on substantial granite masonry towers, and from 150 to 180 ft. back of the latter they are anchored to the natural rock with 4-in. pins. The towers are 52 ft. high above the floor and measure 15 ft. square at the base and 5 ft. 8 in. at the top below the coping stone.

Grand Falls Bridge Similar But Smaller

The Grand Falls suspension bridge also crossed the St. John River, in New Brunswick, but about 210 mi. above the Reversible Falls bridge at the mouth of the river. While the gorge is similar to that at the town of St. John, though much narrower, the type of bridge selected for the new structure is very different from the St. John arch. On account of the unsatisfactory vertical stratification of the rock, the engineers did not think an arch advisable and recommended a truss bridge. The two truss spans are respectively 139 ft. 9 in. and 279 ft. 10 in. long, center to center. The Dominion Bridge Co. built them.

The old suspension bridge was built in 1855, under the superintendence of A. T. Tomlinson. Its span between tower centers was 209 ft. 9 in., and the span of stiffening trusses was 193 ft. 9 in. The roadway was 16 ft. wide in the clear. It was supported by two straight-wire wire-wrapped cables of 5½ in. finished diameter, resting on stone towers 21 ft. 4½ in. high above the floor and anchored 125 ft. back of the towers. The cables were cradled slightly, being 18 ft. apart in midspan and 20 ft. 7 in. apart at the tower. Suspenders of ¾-in. round iron were hung from a 3½x⅜-in. cable band, and carried at the lower end a 3x⅜-in. iron strap passing under the floorbeam and connected to the suspender by a ⅝-in. bolt passing through both ends of the strap and an eye at the lower end of the suspender.

The hard-pine floorbeams, spaced 3 ft. 4½ in. apart, were 4x13, except that every fourth one was 5x13 and was extended out to take an inclined brace to the top chord of the stiffening truss. An unusual feature of the floorbeams was that they were cut longitudinally to a crown of 3 in., the end depth being 10 in. The floor consisted of two courses of 2-in. spruce.

Stiffening trusses, 16 ft. 6 in. apart, 3 ft. 9 in. high, rested on top of the floorbeams and were connected to them by the ⅝-in. vertical truss rods, going through the floorbeams and through special 2x6-in. bottom chords under the floorbeams.

The span was braced laterally by a number of wire-cable side guys running from various points of the trusses to anchorages in the rock at the end of the bridge.

Concrete Railway Trestles

Concrete trestles (or bridges having a series of short slab spans) are being used on a number of railways at points where ordinary pile trestles of low height would be used in new construction or have been used in previous construction. Such structures are of two types—one having concrete pile bents and caps and the other having thin concrete piers to carry the slabs forming the spans.

An example of the latter type of construction is a bridge on the Kansas City Southern Ry., near Anderson, Mo., the design of which is shown in the accompanying drawing. The bridge has eight spans of 12½ ft. in the clear (between piers), with a headway of 5 to 10 ft. It carries the ordinary ballasted track construction.

Details of the Piers and Abutments

The piers are of reinforced-concrete, 30 in. thick, with broad footings, no foundation piles being used. The concrete is proportioned 1:2:4, and the reinforcement consists of square twisted bars of medium openhearth steel, arranged as shown. The abutments are of open box form, with end wall, bottom and side walls parallel with the track. They are embedded in the end of the fill. The concrete for the abutments is proportioned 1:3:5 and is not reinforced.

The top of each pier and the bridge seat of each abutment have two dowels 1¼x10 in. which enter 1¾-in. holes in the slab and prevent the latter from creeping. The tops of the piers and the bridge seats of the abutments are finished to an elevation ¾ in. below the bottom of the slabs. When the slabs are being set in place, this space is filled with cement mortar and a zinc plate $\frac{1}{32}$ in. thick is placed between the mortar joint and the slab, this plate extending over the full area of the bearing surface.

Concrete-Slab Superstructure

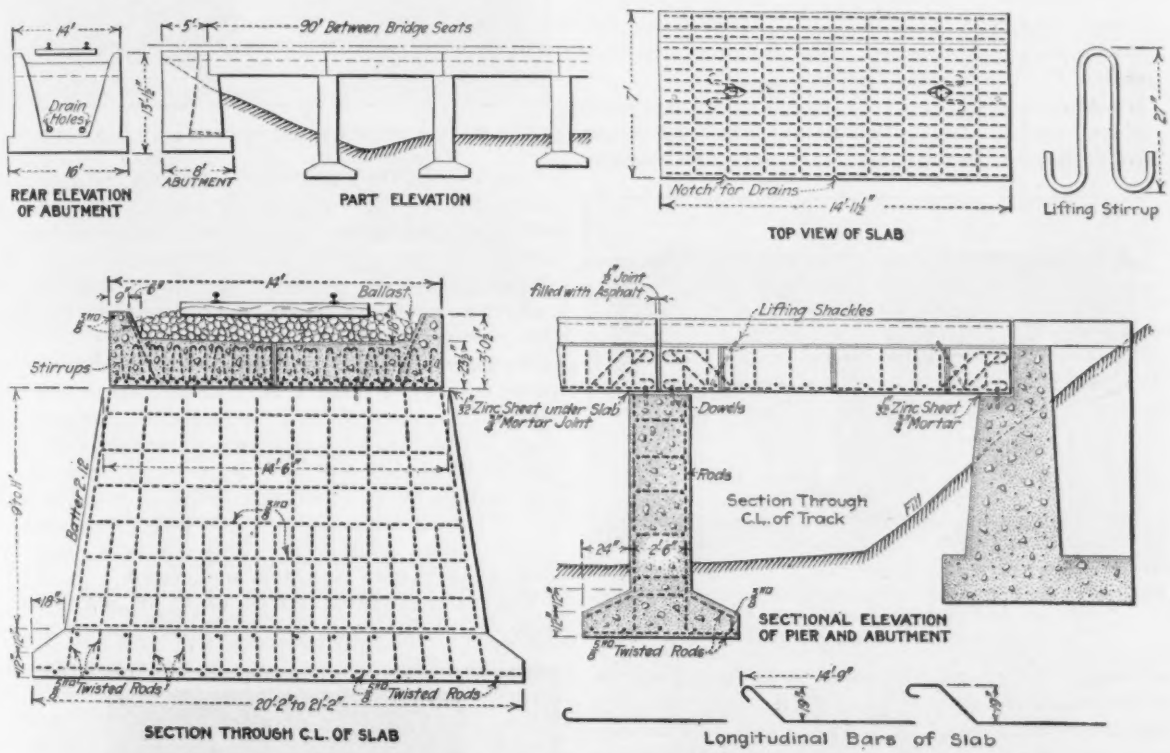
The deck, or superstructure, consists of a double row of concrete slabs, which are cast at a convenient place and set in position by derrick cars when the piers are completed. Each slab is 14½ ft. long and 7 ft. wide, with a curb wall along one side, so that the two slabs form a trough to contain the ballast. The minimum thickness is 23½ in., at the inner side, where grooves in the faces of the slabs form vertical drain holes.

The concrete for the slabs is mixed 1:2:4. The steel reinforcement consists of longitudinal square twisted bars (having the ends bent as shown), with transverse bars, and vertical transverse stirrups looped under the horizontal bars. For hoisting, each slab has two stirrups, or shackles, set at an angle of 60°, the top of the concrete having a pocket around the projecting loop.

The slabs are set with their ends ½ in. apart, the spaces being filled with asphaltum or some bituminous paving composition. Each slab contains 8⅓ cu.yd. of concrete and 1,115 lb. of reinforcing steel. The total estimated weight, including 60 lb. for the hoisting stirrups, is 34,000 lb.

Gravel ballast is filled to a depth of 18 in. below the tops of the ties, the rails being above the level of the curb walls.

A number of these bridges have been designed and built under the direction of C. E. Johnston, Chief Engineer of the Kansas City Southern Ry.



CONCRETE TRESTLE WITH PIERS AND SLAB DECK SPANS; KANSAS CITY SOUTHERN RY.

Causes of Failure in Creosoted Wood-Block Pavement

SYNOPSIS—A careful study of existing creosoted wood-block pavements shows that many theories previously held as to the effect of the addition of coal tar to creosote oil are wholly untenable. Results of a series of experiments to determine the law of penetration of wood-paving blocks.

Some radical changes made in the specifications for creosoted wood-block pavements tentatively adopted by the wood-block pavement subcommittee of the American Society of Municipal Improvements, at the convention held in Dayton, Ohio, Oct. 12-14, 1915, were in a large measure brought about by the arguments of Dr. Hermann von Schrenk, Consulting Engineer of the Yellow Pine Lumber Manufacturers' Association, whose paper, "Oil Specification for Creosoted Wood Block," aroused much interest and discussion. This paper contains a collection of data gathered from an extensive investigation of existing wood-block pavements, which should be of great interest to every municipal engineer contemplating this type of paving construction. The following article is based on Dr. Von Schrenk's paper.

Heretofore, discussion of wood-paving block specifications have been largely theoretical. These discussions have dealt with the relative advantages or disadvantages

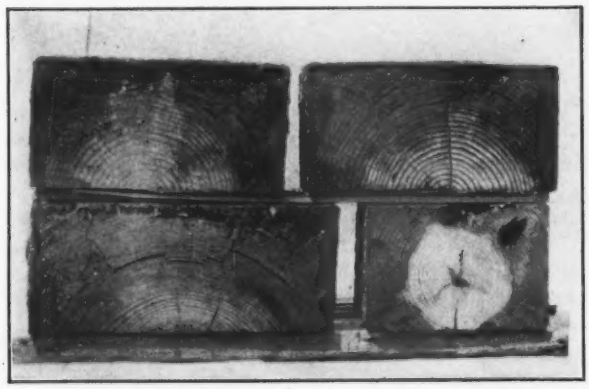


FIG. 1. CROSS-SECTIONS THROUGH MIDDLE OF DEFECTIVE WOOD-PAVING BLOCKS, ST. LOUIS, MO.
Sections show nature of failure

of straight coal-tar creosote, additions of refined coal tar to creosote, water-gas tars, etc.—theories unsupported by experience and clouded by a general lack of knowledge as to what the various terms meant; even at the Dayton convention there was a difference of opinion as to just how to define commercial creosote.

Actual Experience with Creosote Preservatives

A study of European specifications for wood-preserving oils has likewise shown wide variation in requirements, but at the same time uniformly satisfactory results. All these specifications, however, distinctly require that the oil shall be a coal-tar creosote derived from strictly pure coal tar. European experience has further shown that any good creosote derived from pure coal tar injected in proper quantities into sound seasoned timber protects the timber from decay for 25 or more years. The particular percentage of naphthalene, tar acids, etc., appears to have very little to do with results.

Acting on the theory that the character of the oil is of relatively small importance in the success or failure of creosoted wood-block pavements, Dr. Von Schrenk made a careful examination of a large number of American street pavements from 10 to 15 yr. old. The results of these examinations clearly showed that in the majority

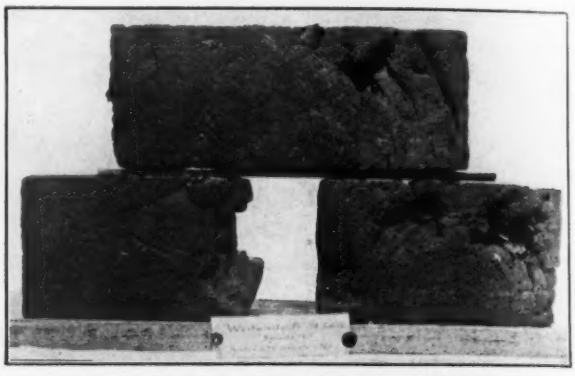


FIG. 2. TOP VIEW OF DEFECTIVE ST. LOUIS BLOCKS

of cases—practically universally—failures and defects in streets paved with creosoted yellow-pine blocks could be attributed to improper laying, poor foundations, omission of expansion joints, want of proper drainage, etc. Failures caused by decay of the blocks were far less numerous, and such failures were usually in comparatively old pavements.

Very thorough examinations were made of two wood-paved streets in St. Louis, Mo. In addition to removing many of the decayed blocks a careful examination was made of the sound blocks in the immediate vicinity of those decayed. Oil was extracted from the sound blocks and analyses made, which were compared with the analyses of the oils originally used. On both streets what are usually known as extremely light oils were used; one showed evidences of petroleum adulteration.

The causes of failure in these blocks are laid to one or more of the following: (1) Insufficient amount of oil;

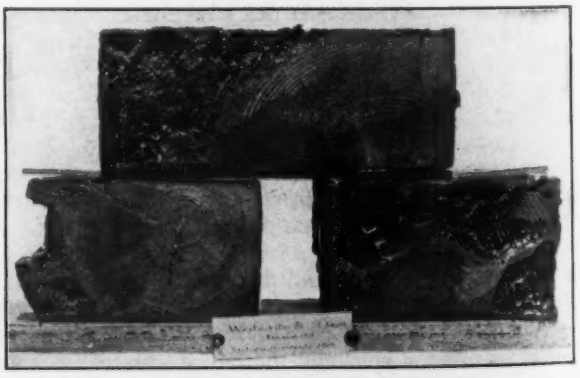


FIG. 3. CROSS-SECTION THROUGH MIDDLE OF BLOCKS SHOWN IN FIG. 2

(2) poor penetration, particularly of the sapwood; (3) use of oil containing petroleum compounds instead of one of strictly coal-tar origin; (4) insufficient absorption due to high water content in the sapwood; (5) use of a very light naphthalene-containing oil, a large percentage of which had evaporated from the blocks.

None of the blocks treated with a straight coal-tar oil showed decay in any of the sapwood which still contained the preservative, which could not be said of the blocks treated with the oil containing petroleum.

Similar examinations were made of streets in Toledo, Ohio, which served to indicate even more strongly than those in St. Louis that the two factors—poor quality of oil (that containing petroleum additions) and insufficient penetration—had in all probability caused the failures. The failure of blocks in a pavement in Charleston, S. C., was traced to the use of a straight water-gas oil and very poorly penetrated blocks.

Efficient penetration depends on the condition of the timber—its water content and soundness; on the character of the wood treated; on the volume of oil injected; to a slight degree on the character of the oil used—that is, the percentage of insoluble matter; and on the temperature employed during the treating process.

From his own investigations Dr. Von Schrenk has come to the conclusion that in treating paving blocks the

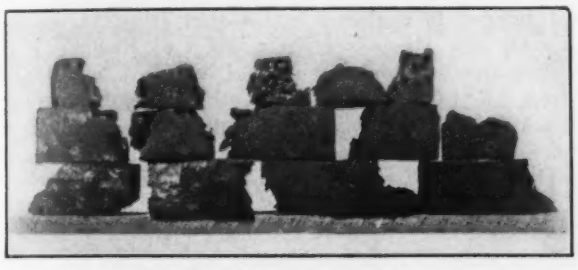


FIG. 4. TOP VIEW OF SOME DEFECTIVE BLOCKS FROM CHARLESTON, S. C.

absorption and penetration are determined by two factors—(1) The individual characteristic of the piece of wood to be treated, that is, the natural density and the percentage of water contained in the individual stick, and (2) the volume of the oil injected.

The densest piece absorbs the least quantity of oil, the most porous piece the highest quantity, when both are treated in the same charge under the same conditions. Pieces with high water content absorb less oil than those with low water content. A charge into which an average of 20 lb. per cu.ft. of creosote is injected shows better penetration than one in which only 10 lb. per cu.ft. is injected.

Experiments To Determine Law of Penetration

In order to determine the law of penetration for paving blocks, a number of experiments were made, using both a solution of coal tar and creosote oil and a straight creosote oil. Five different tests were conducted, each at a different treating plant. In each case 100 paving blocks, picked at random, were carefully weighed individually before treatment. Each block was carefully numbered for identification.

These 100 blocks were treated in a regular charge, and immediately after the treatment the blocks were weighed again, to determine the amount of oil absorbed. The results of these five tests were plotted on diagrams. There were two diagrams for each test, one set showing the variation in absorption in the 100 blocks, without relation to the weight of the individual blocks before treatment. At the bottom of the diagram two scales were given, the lower one showing the number of ounces absorbed, the upper showing the number of pounds per cubic foot. Individual crosses were used to show the number of paving

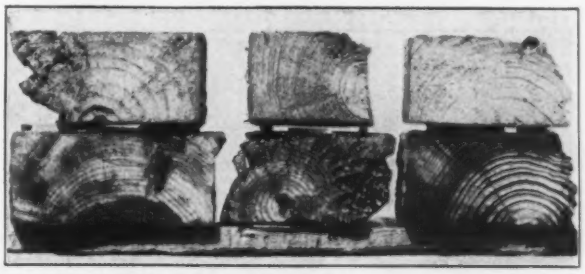


FIG. 5. CROSS-SECTION THROUGH MIDDLE OF BLOCKS SHOWN IN FIG. 4

blocks which absorbed the quantity of oil indicated by the figures at top and bottom.

A study of these charts shows that no matter what kind of oil was used, no matter at what plant the blocks were treated and irrespective of the condition of the timber at the time of treatment, there was a small number of blocks in each case which absorbed a comparatively small quantity of oil. Similarly a small number of blocks absorbed a comparatively large quantity of oil, and between these two there were various degrees of absorption; but the largest number of blocks invariably fell near the point which gives the intended average absorption.

The other set of charts shows the relation between the weight of individual blocks and the amount of oil absorbed per cubic foot in those blocks. These charts also show that irrespective of the kind of oil used or the kind of timber, there is a definite relationship between the weight before treatment and the amount of oil absorbed. The denser and heavier the block the smaller is the quantity of oil which it absorbs. That there is an important

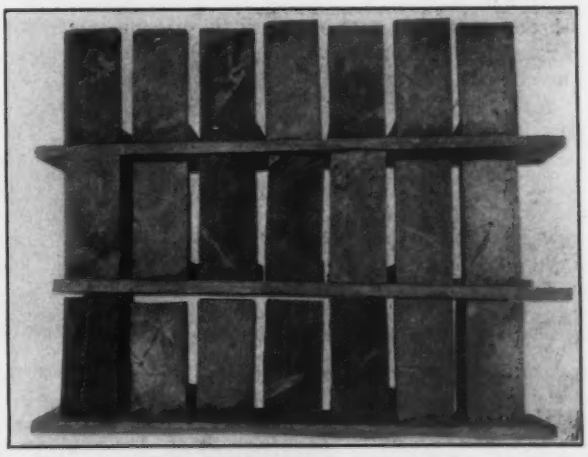


FIG. 6. EFFECT OF CREOSOTE OIL

Cross-sections of Southern yellow pine paving blocks treated with English distillate creosote oil

Ounces of oil absorbed per block:							
Top row	24	23	22	20	19	18	15
Middle row	14	13	12	12	12	11	10
Bottom row	10	9	9	8	7	7	6

relation between the amount of oil absorbed per block and the penetration is of course obvious. Blocks which absorbed only 2 oz. of oil showed a far different penetration from those which absorbed 30 oz.

Conclusions from Accumulated Data

The conclusions drawn from all these experiments and the examinations of actual conditions in the street are that a thorough penetration of every block is impossible,

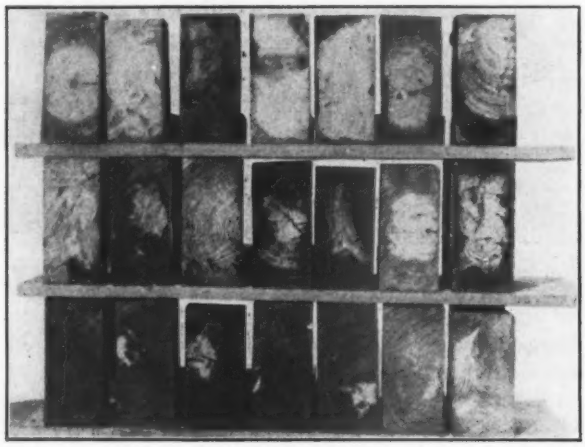


FIG. 7. EFFECT OF COAL-TAR-CREOSOTE SOLUTION

Cross-sections of yellow pine paving blocks treated with coal-tar-creosote solution

Ounces of oil absorbed per block:

Top row	3	6	7	8	8	9	10
Middle row	16	16	16	16	16	16	16
Bottom row	26	24	23	23	23	22	22

Analysis of Oil

Sample number		3026
Specific gravity at 38° C.		= 1.110
Distillation:	200° C.	2.0%
	210	3.7
	235	22.2
	270	36.7
	315	45.2
	355	57.7
Residue:		42.3

but that a thorough penetration of the sapwood is absolutely essential for the preservation of the block. This, Dr. Von Schrenk claims, can be easily obtained, provided sufficient quantities of oil are used and provided that the process of injection is properly conducted, irrespective of whether a straight creosote distillate oil or a solution of a reasonable amount of coal tar and creosote is used for preservative.

As to bleeding of newly laid wood-block pavements, Dr. Von Schrenk is sure that both the straight creosote and the coal-tar solution stand on identically the same basis, provided the method of treatment is faulty. The criterion to be used in specifying the preservative ought to be only availability and cost. Both creosote oil and creosote oil mixed with coal tar are available and should be used. A reasonable addition of coal tar to creosote is held to be good practice, but according to Dr. Von Schrenk, a straight coal-tar product free from the admixture of other substances should be specified.

Crossties Used in Brazil are estimated at 1,500,000 per annum. The life of each tie is five to six years. The woods used are faveiro, jacaranda and peroba mirim. These woods are high-class, as is also much of the timber employed as fuel by the railways. Consul General Alfred L. M. Gottschalk states that some effort has been made by certain municipalities to introduce wood-block paving, but that this paving has never been widely used in Brazil, in spite of the excellent and suitable woods of the country.

Track Bolts of Alloy Steel

The important part played by the bolts in a rail joint is well understood by every engineer who has made a study of rail-joint design. It is absolutely necessary that the angle bars be held firmly against the head and the foot of the rail in order that they shall act with the rail in stiffening the joint. With track bolts made of ordinary steel, however, it is very common for such an initial stress to be put on them in screwing them up that the bolts will be stretched beyond the elastic limit and will fail under the shocks of service. It is undesirable to increase the diameter of track bolts, as this means a larger hole through the web of the rail.

A very important development in track material was brought out some four years ago by the Pennsylvania Steel Co., which at that time began manufacturing track bolts of its special Mayari steel. It will be recalled by many of the readers of *Engineering News* that this product of the Pennsylvania Steel Co. is a natural nickel-chrome steel manufactured from iron deposits on the north side of the island of Cuba, which contain a certain percentage of nickel and chromium. Deposits of this ore are enormous in extent, and it is mined by processes quite similar to those used in mining the Mesaba iron ore. This material is now used in various classes of steel products by the Pennsylvania Steel Co. One important application of interest to engineers is the steel structural shapes for the new Mississippi River bridge at Memphis.

Mayari steel contains about 1 to 1½% nickel and from 0.2 to 0.5% of chromium. In the manufacture of track bolts this alloy steel is heat-treated, producing a material with an ultimate strength of over 100,000 lb. per sq.in. and an elastic limit of over 75,000 lb., a reduction of area of at least 40% and an elongation of at least 15% in 2 in. These are specification limits, and much of the material runs considerably higher than the above in elastic limit and ultimate strength. Bolts of this type are used exclusively by the Pennsylvania Steel Co. in its best grade of frog and switch work. The Pennsylvania Railroad Co. has adopted these bolts for frogs and purchased large quantities for use in rail joints. The Pennsylvania R.R. specifications for ordinary splice bolts call for steel with an elastic limit of 28,000 to 33,000 lb. per sq.in. It has been shown that a trackman can steadily apply a load of 45,000 lb. with an ordinary short wrench, and possibly as high as 60,000 lb. if he applies his full force or uses a pipe handle to lengthen the wrench for his convenience.

Tests on track bolts of ordinary steel and heat-treated alloy steel are recorded in a recent bulletin of the Railway Engineering Association by Earl Stimson, Engineer of Maintenance-of-Way, Baltimore & Ohio R.R. The object was to show the relation between the elastic limit of the bolts and the loads put upon them by the use of wrenches of various length. With ordinary bolts the elastic limit was exceeded when 42-in. wrenches were used, running as high as 42,600 lb.

From these tests it was concluded that for ordinary bolts the use of wrenches over 36 in. long not only involves the risk of stressing the bolts beyond their elastic limit, but so injures the nuts as to necessitate cutting them for removal. With the alloy-steel bolts, not even a 48-in. wrench, under any kind of normal application, could give a pull anywhere near the elastic limit.

Buffalo Completes Huge New Pumping Station

The large new pumping station of the City of Buffalo, which has been under way for several years at Porter Ave., is now practically complete and is in service. The Buffalo Common Council has adopted the name "Col. Francis G. Ward Pumping Station" for this plant in place of the old common and unofficial designation of Porter Ave. station. This has been done to honor the memory of Colonel Ward, whose recent death ended 20 years of conspicuous service as Chief of the Bureau of Water and as Commissioner of Public Works.

The Buffalo water-works were started in 1849 by a private company. The city purchased the plant in 1868 when the city had a population of 100,000 and a daily consumption of 4,000,000 gal. Then all water was pumped from the Niagara River by a 4,000,000-gal. Cornish bull engine (made in 1851 by I. P. Morris, of Philadelphia) and a 6,000,000-gal. beam engine (made by Shepard Iron Works, of Buffalo, in 1866). The supply was much contaminated with sewage. As the city grew, the pipes were extended, additional pumps were erected and haphazard additions were made to the station building to house them.

The first improvement under city administration was the construction of a new intake in the center of the Niagara River, placed there on the old theory that running water purified itself. In springtime the pumps were choked with slush ice. From the beginning of Colonel Ward's connection with the City Water Department, an intake in Emerald Channel and a duplicate pumping station at the foot of Porter Ave. were advocated. The plans were examined and recommended by experts several times, but nothing was done up to the time when he became Commissioner of Public Works. In 1907 a contract was let for the construction of a new intake tunnel and intake from Emerald Channel. While the new tunnel was being built, the foundations were laid for the new pumping station. In 1909 a contract was let for the superstructure, but the completion of the building was delayed because of an unfortunate accident by which the roof trusses fell.

General Design of Station

The building is of brick, with terra-cotta trimmings, a dressed-stone base and a concrete and tile roof. It is fireproof throughout. The general appearance is shown in Fig. 1 and the arrangement in Fig. 2. The engine room is 90 ft. wide by 364 ft. long and has foundations for eight 30,000,000-gal. triple-expansion steam pumps. Five of these have been installed. In back of the engine room, and at right angles to it, is a boiler room 100x200 ft., with a 45x100-ft. coal-storage space back of that. The boiler room has been designed for 16 boilers, in two rows of eight, and has two brick stacks 250 ft. high and 11 ft. in diameter at the top. Only one row of boilers has been installed. The rated capacity of each boiler is 750 hp.; each has 7,500 ft. of heating surface and is equipped with moving-grate stokers and superheaters. Coal is brought in from the New York Central tracks. A conveyor receives coal from the car and delivers it into the shed or the boiler bunkers. The same conveyor feeds from the storage-shed into the bunkers. The coal tracks have a spur to the south end of the engine room, and the crane tracks for the engine room run out over it, so that the 30-ton crane can pick up a shipment and place it anywhere in the engine room.

A 40x235-ft. extension to the rear of the north end of the engine room contains the storeroom and the office of the plant engineer. A similar extension to the rear at the south end of the engine room contains the ma-

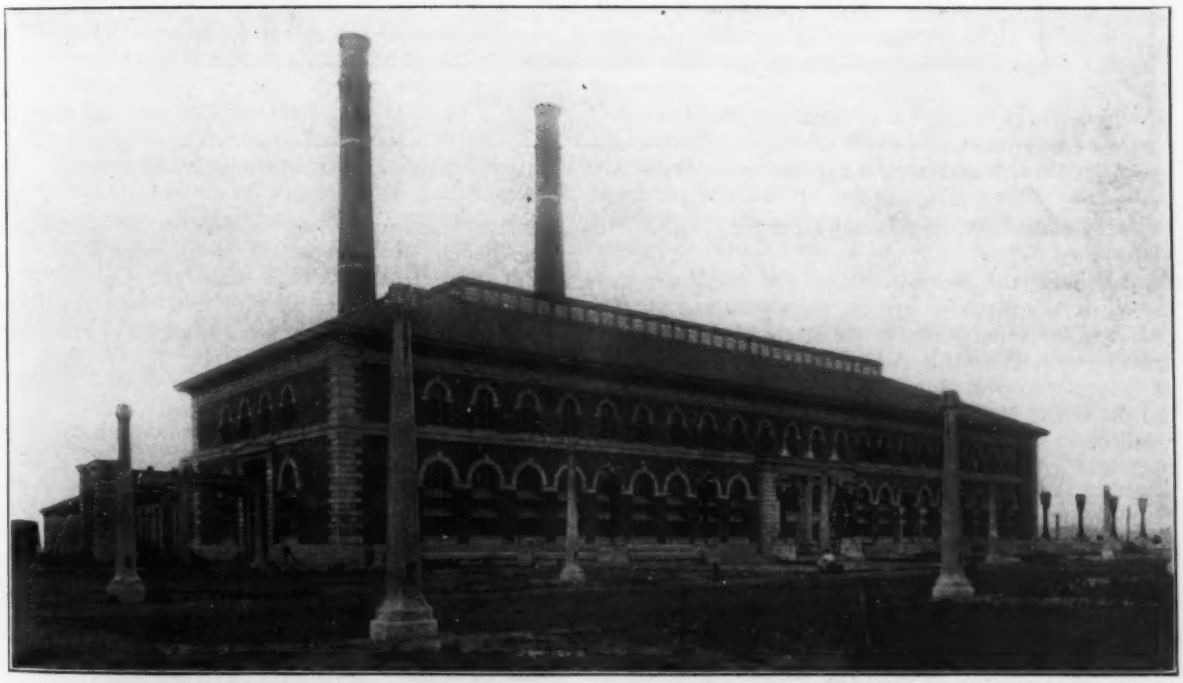


FIG. 1. THE COL. FRANCIS G. WARD PUMPING STATION, BUFFALO, N. Y.

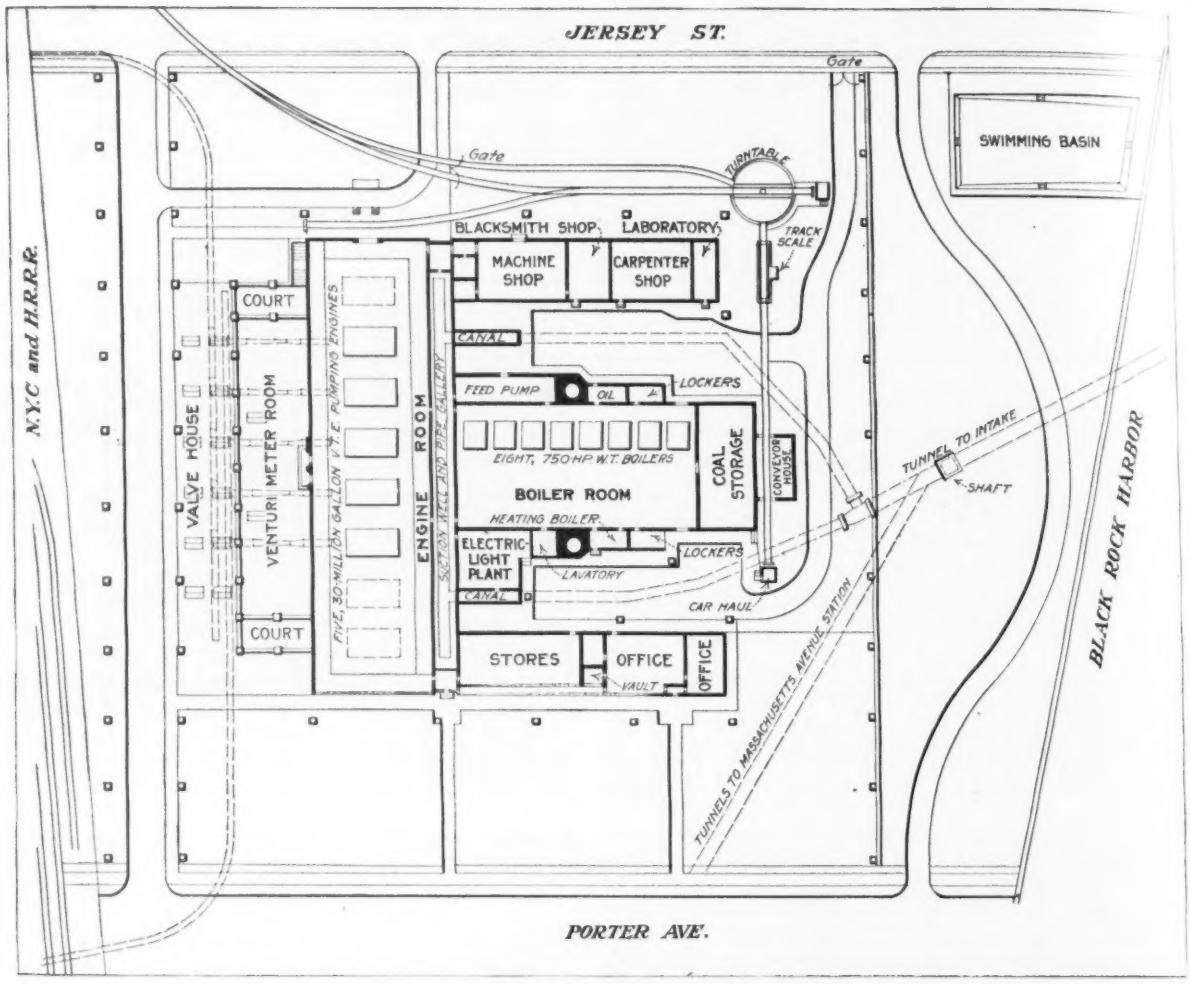


FIG. 2. GENERAL PLAN OF THE COL. FRANCIS G. WARD PUMPING STATION, PORTER AVE., BUFFALO

chine, blacksmith, carpenter and paint shops, and a small laboratory.

Adjoining the boiler room on the north side is a small electric plant for lighting the station and grounds, and for supplying power to the small pumps and other machinery. This plant will also furnish light and power for the department storehouse, a short distance off, and to the intake pier, on which some little apparatus is installed.

Wells; Venturi and Valve Rooms

Adjoining the boiler room on the south side is a hot-well to which the condensed steam returns from the engines. Alongside the well are two steam boiler-feed pumps with a feed-water heater and purifying system.

In the rear of the engine room is a covered suction well 20 ft. wide and 325 ft. long, with the water in it 20 ft. deep. It is supplied through two covered canals extending from the shore shaft of the new 12-ft. tunnel and so divided by gates that any part of the canals or pump-suction wells can be cut off for cleaning without interfering with the rest of the canals or wells.

One of the most interesting features of the entire station is the provision of venturi-meter and valve rooms in front of the engine room. The meter room is 55x235 ft. and is built below the ground grading line. In it are five 48-in. venturi meters—one in the discharge of each pump. In front of the meter room is the valve room, 45x300 ft., also built below the grade line. In this chamber, as shown in Fig. 4, the 48-in. discharge lines from the engines pass at right angles over two pairs

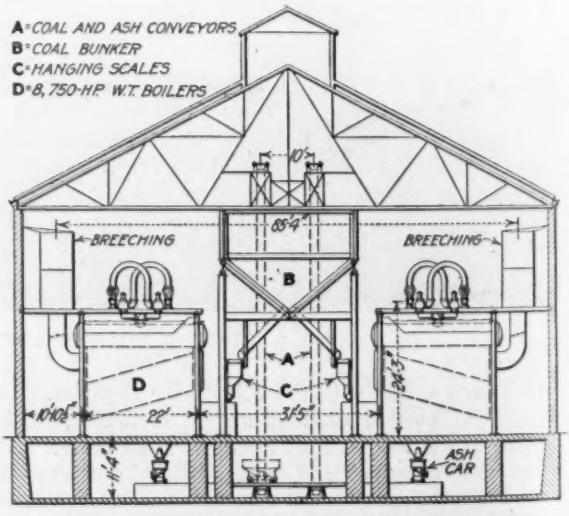


FIG. 3. SECTION THROUGH BOILER ROOM

of 60-in. cast-iron pipe lines extending into the city distribution system. One is on the high service and the other on the low. Each 48-in. pipe is connected to the four 60-in. pipes by 36-in. T's and a 36-in. hydraulically operated valve. A pump can be changed from one service to another, in less than 5 min., by opening and closing two 36-in. valves.

Improving the Old Station; Statistics

While the new station has been under way, the old Massachusetts Ave. station has been entirely rebuilt into a modern fireproof building. The old horizontal pumps have all been removed and four new 30,000,000-gal. vertical triple-expansion units have been erected in their places. Two of the old 30,000,000-gal. vertical triple-expansion pumps remain—overhauled and put in good condition.

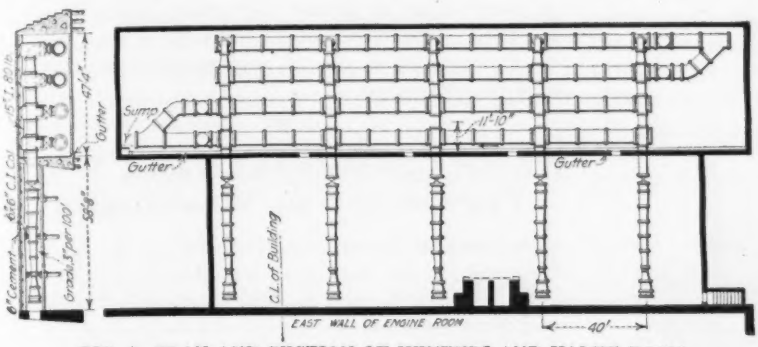


FIG. 4. PLAN AND SECTION OF VENTURI AND VALVE ROOM

The boiler rooms of the old station have also been rebuilt, furnished with new brick chimneys and equipped with sixteen 300-hp. horizontal tubular boilers each and four 600-hp. water-tube boilers.

The present population of Buffalo is 475,000. The total consumption for the year ending June 30, 1915, was 52,896 million gallons, of which 15,548 million passed through meters. The average daily consumption was 148.1 million gallons, giving 312 gal. per capita per day. The total cost of supplying water per million gallons, figured on the total maintenance item of the department (old station only), was $11.07. The total cost of supplying water, including the interest on bonds, was $19.53 per million gallons during the same fiscal year.

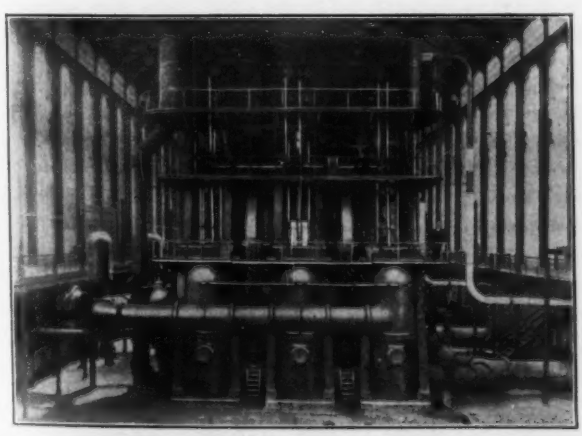


FIG. 5. HOLLY ENGINE NO. 1; COL. FRANCIS G. WARD PUMPING STATION, BUFFALO

Utility-Franchise Policy for a Model City Charter

The public-utility and franchise policy embodied in a model city charter should be so formulated as to conserve and further certain definite purposes, according to the principles adopted by the Municipal Program Committee of the National Municipal League (North American Building, Philadelphia), which is engaged in framing such a model city charter. These purposes may be outlined as follows:

1. To secure to the people of the city the best public-utility service that is practicable.

2. To secure and preserve to the city as a municipal corporation the fullest possible control of the streets and of their special uses.

3. To remove as far as practicable the obstacles in the way of the extension of the practice of municipal ownership and operation of public utilities, and to render practicable the success of such ownership and operation when undertaken.

4. To secure for the people of the city public-utility rates as low as practicable consistent with the realization of the three purposes above set forth. It should be no part of such policy to secure compensation for franchises or special revenues for general city purposes by an indirect tax upon the consumers of public-utility services.

In formulating a policy to carry out the four purposes above stated as desirable, the following principles should be recognized:

1. Each utility serving an urban community should be treated as far as practicable as a monopoly with the obligations of a monopoly; and its operation within the city should be based as far as practicable upon a single comprehensive ordinance or franchise grant uniform in its application to all parts of the city and to all extensions of plant and service as well as to the existing plant and service.

2. Every franchise should be revocable by the city upon just compensation being paid to its owners, when the city is prepared to undertake public ownership.

3. The control of the location and character of public-utility fixtures, the character and amount of service rendered and the rates charged therefor should be reserved by the city, subject to reasonable review by the courts or a state utilities commission where one exists.

4. Private investments in public utilities should be treated as investments in aid of public credit and subject to public control, and should be safeguarded in every possible way; and the rate of return allowed thereon should be reduced to the minimum return necessary in the case of safe investments with a fixed and substantially assured fair earning power.

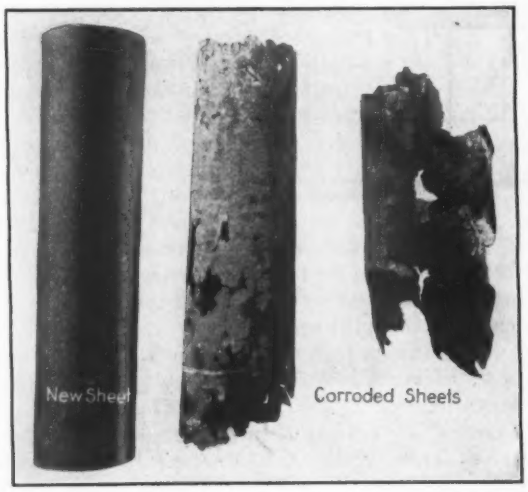
5. The granting and enforcement of franchises and the regulation of utilities operating thereunder should be subject to adequate public scrutiny and discussion and should receive full consideration by an expert bureau of the city government established and maintained for that purpose, or in case the maintenance of such bureau is impracticable, by an officer or committee designated for the purpose.

Guarding Steel Lock Gates from Galvanic Action

By Edward C. Sherman*

The lock in the Charles River dam at Boston is provided with steel caisson gates which roll back into recesses in the lock walls. The gates are supported on specially arranged trucks, having steel wheels and Parsons manganese bronze axles, each truck being inclosed in a chamber open at the bottom and ordinarily filled with water, although this water can be blown out by compressed air and the truck chamber reached from above by means of an air lock.

The possibility of serious galvanic action between the structural steel of the gates and the bronze of the axles when immersed in sea water was recognized when the gates were being designed, and tests were carried on during a period of about two years to find out whether a



SHEETS OF ZINC USED FOR PROTECTING FROM CORROSION LOCK GATES OF CHARLES RIVER DAM

suggested system of zinc plates could be expected to afford any protection by polarizing the steel. These tests were described in *Engineering News* of March 18, 1909. They indicated that very considerable protection would be afforded by such means, the best results being obtained with the zinc in contact with the steel; but as such an arrangement was not practicable, it was decided to wrap sheets of zinc around the bronze axles.

The lock gates have now been in use for about six years, and the zinc sheets have been replaced two or three times each year. The accompanying illustration shows the appearance of a new zinc plate and of some plates which have been removed after several months' use. The protection afforded appears to have been complete, as the steel of the truck chambers becomes corroded no more than the other immersed parts of the gate. It is possible, however, that this is partly due to the presence in the chambers of considerable lubricating oil, which escapes from the truck bearings, to which it is forced under pressure, and which adheres to the steel plates. The destruction of the zinc indicates, however, that galvanic action exists, and it is probable that without the zinc the steel would be vigorously attacked in spite of paint and oil.

The lock gates are painted inside and out at least once in two years with pure red lead and linseed oil, which has been found to outlast any other coating that has been tried. The outside of the gates above the low-water line also receives a coat of gray graphite paint to improve its appearance.

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Water Consumption and Waste Prevention at Washington

The recently issued annual report of the Engineer Department of the District of Columbia for the year ending June 30, 1915, contains some interesting data on the water consumption of the district and the measures which have been taken to reduce it to reasonable figures. The mean daily total consumption for the year was 52,512,000 gal., which is an average daily consumption per capita of 144 gal. This, it will be noted, is still above the average of metered cities.

The accompanying diagram shows the total daily consumption and the per capita daily consumption, the increase in the number of services and the increase in population from 1896 to 1905, when the peak in water consumption occurred; and from 1905 to 1915. In 1905 the per capita daily consumption had climbed to 227 gal., and measures were then instituted to stop waste. The decrease in per capita consumption since then has been 33%, and it is aimed to reduce the consumption to 130 gal. per capita per day.

On the diagram are also given the curves for the number of meters installed each year, and the millions of gallons daily in underground leaks in the distribution system which have been stopped. The total number of meters installed to June 30, 1915, was 48,411 on a total number of services of 68,365, so that 30% of the services are still unmetered. It is estimated that the city will be practically 100% metered by 1918. To stop underground leaks systematic pitometer surveys are constantly being made. During the year 1914-15 leakage at the rate of 1,828,800 gal. per day was located and stopped, the total cost of this being only $33,500. A total of 382 leaks

TABLE OF SOURCES AND DAILY QUANTITIES OF UNDERGROUND LEAKAGE, 1907 TO 1915, IN GALLONS

Class	1907-8	1908-9	1909-10	1910-11	1911-12	1912-13	1913-14	1914-15
Abandoned taps and services			355,300	173,600	174,200	180,900	101,700	54,700
Iron services	2,729,000		2,438,000	1,508,900	2,329,800	1,988,800	924,000	861,950
Lead services			1,201,900	1,237,600	976,700	394,000	471,000	254,100
Wiped joints	327,000		710,100	666,700	438,100	282,300	237,000	213,500
Couplings		5,214,000	118,700	182,900	123,700	75,600	66,900	20,500
Stopcocks			84,800	43,300	53,500	32,900	16,900	17,150
Street washers				42,000	10,400	5,700	500	
Joints on mains	1,039,900	1,345,600	1,034,200	2,562,500	746,300	962,300	596,800	368,800
Broken mains	1,200,000	117,000	332,000	15,900	7,000	103,300	62,200	
Valves	23,500	62,000	89,100	110,900	27,100	13,200	6,800	300
Blowoffs		737,000		176,600	71,300	6,000		
Fire hydrants	174,000	45,000		19,200	3,500	115,000	500	5,120
Public hydrants				84,200	50,200	21,000	12,000	500
Unclassified	111,000	2,039,500		97,600	103,800	15,000	56,500	32,200
Total	5,604,400	9,560,600	6,364,100	6,921,900	5,115,600	4,196,000	2,552,800	1,828,820

was found, and the average waste per leak was 4,800 gal. daily.

To find the 382 leaks, 50,054 examinations (including ordinary leaks at house fixtures) were made, or one leak was found to every 132 examinations. The extremely good record made by the pitometer survey division is ascribed chiefly to the introduction, development and successful operation of the manograph (*Engineering News*, Jan. 6, p. 48). The report of Paul Lanham, pitometer operator, states that "this instrument has proved of such value as to completely displace all other pitometer recording apparatus, and it produces results heretofore unobtainable." The number of houses inspected was 17,563, and the number of leaking fixtures found was 1,691, or 9.6%. In 1907 when pitometer surveys were begun, the ratio of house leaks to house inspection was 16%, which shows that the waste from this source has been greatly reduced.

The accompanying table gives a summary of the sources and amounts of leaks since 1907.

The water department of Washington is now organized on a profitable basis, notwithstanding water is furnished free to many institutions. The department closed the year ending June 30, 1915, with nearly $100,000 balance. The rate charged for water on meter services during the year was 4c. per 10 cu.ft. for all used in excess of 7,500 cu.ft. The minimum charge for 7,500 cu.ft. is $4.50 per annum. The average annual payment where meters were installed by the District of Columbia was $5.51. Water-rent bills are delivered to the householder annually at the minimum rate, which allows the use of 7,500 cu.ft., or 56,100 gal. If on actual measurement water is found to be used in excess of this amount, bills are rendered for such excess at the rate of 4c. per 100 cu.ft.

On the water services which are not metered, water for domestic purposes is charged according to the number of stories and frontage. For premises of two stories with a front width of 16 ft. or less, the minimum rate is $5 per annum; for each additional front foot or fraction thereof, 31c. is charged. For each additional story one-third of the charges as computed above is added. For business premises not metered, rates vary from $1 to $25 per annum. Where the rate is $25 or more, a meter is required to be installed at the expense of the consumer.

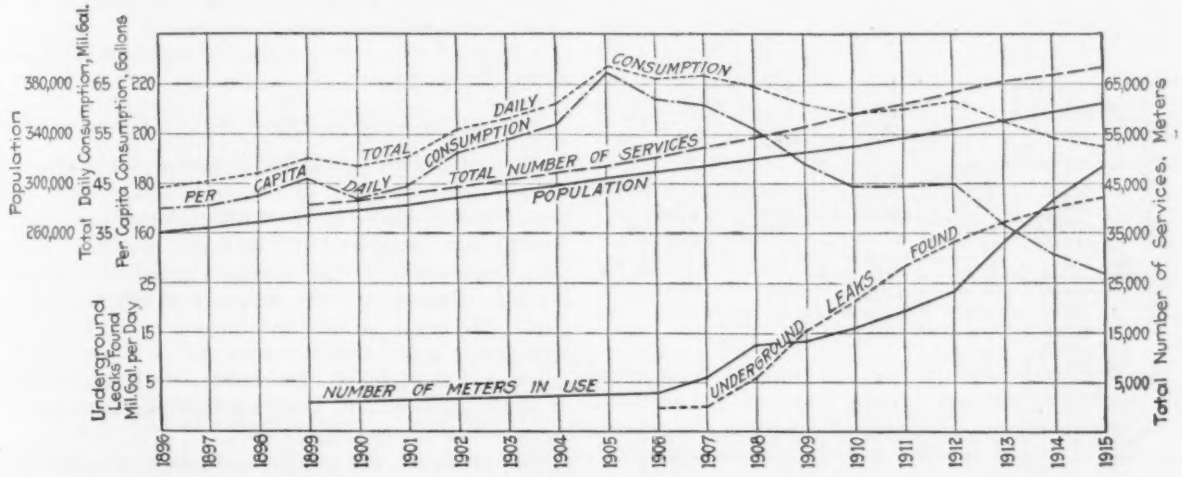

CHART SHOWING WATER CONSUMPTION, METERS INSTALLED, UNDERGROUND LEAKAGE STOPPED, ETC., IN THE DISTRICT OF COLUMBIA

A 12-Mi. Railway Built by Hand in Five Months

The Brinson Ry., now the Savannah & Northwestern Ry., which runs from Savannah to St. Clair, Ga., was extended 12 mi. in 1912-13; the grading being done by station work and the extension surveyed and line put in operation in five months. The new line has a series of undulating 1% momentum grades with a maximum grade of 3%, the grade line as built being so laid down that it can be readily changed to a 1% maximum grade. There were two reasons for this procedure; first, only $150,000 was available for construction; second, the necessity for rapid work in order to be ready to handle the heavy fertilizer shipments which go forward in Georgia between the first week in February and the last week in March.

The preliminary survey started on Sept. 30, 1912. Location commenced on Oct. 7, grading and construction on Oct. 25, and track laying on Nov. 20. The first trains were operated on Feb. 22, 1913, and the new road was in regular operation on Mar. 27. The 12-mi. extension from Waynesboro to St. Clair included 680 ft. of permanent trestle, 1,230 ft. of temporary trestle and 2,270 ft. of temporary log cribbing through swamps. The earth handled totaled only 143,000 cu.yd. The work included a transfer yard at St. Clair, where the railway connected with the tracks of the Georgia & Florida R.R., the location of station sites, and three sidings.

The grading was done by hand except for a 20-ft. cut and the 28-ft. fill at Beaver Dam crossing, each about 600 ft. long, upon which wheeled scrapers were used. Work went on simultaneously all along the line. There were bridge gangs building trestles, and gangs for clearing, grading and track laying. The excavation was clay interspersed with strata of kaolin, which was very treacherous when wet and had to be wasted.

The laborers were negroes, and in order to make rapid progress the construction was done by station work. The cuts were 18 ft. wide at the bottom and averaged 3 to 4 ft. in depth. The fills were 16 ft. wide at the top and from 3 to 4 ft. deep. The sides of the cuts were made vertical, as otherwise the kaolin caused slides. The extension was built by Westinghouse Church Kerr & Co.

Building Relief and Outlet Sewers at Chicago

SYNOPSIS—The new Union Station at Chicago will cut off a new storm-water relief sewer and some sewer outlets. As a substitute, diversions and three new outlets have been built. One of these has two compartments, the second being for storm water, which flows over a weir when the sewer proper is carrying its full capacity. A 400-ft. chute for spouting concrete is described.

The sewer outlets in the business district of Chicago lying west of the river are affected considerably by the construction of the new Union Station. All of the ten streets from Fulton to Harrison inclusive had sewer outlets, but eight of these outlets will be cut off, as the railways objected to any sewers extending across the station site. Instead there will be three new outlet sewers at Fulton, Washington and Harrison St., as shown on the map, Fig 1, with suitable connections to the present sewers.

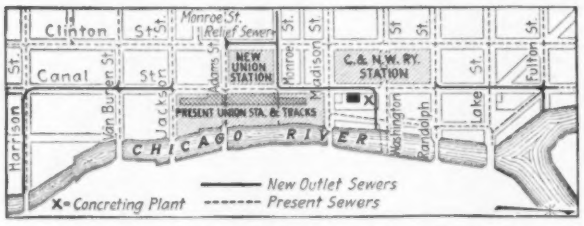

FIG. 1. NEW OUTLET SEWERS MADE NECESSARY BY THE NEW UNION STATION AT CHICAGO

The capacity is 500 cu.ft. per sec. from the Washington St. outlet and 100 cu.ft. per sec. from each of the others.

The arrangement and design of the outlet sewers were worked out jointly by Cicero D. Hill, chief engineer of the Board of Local Improvements, and Alonzo J. Hammond, principal assistant engineer of the Chicago Union Station Co. This company pays the cost of the outlet, as it is a part of the work necessitated by the new station. The contractor is the W. J. Newman Co., of Chicago.

Relief Sewer and Outlet Around Station

The sewer system of the West Side section of the city is old, and with the great increase in the density of population in this section of the city its capacity has become quite inadequate to present needs. After heavy rains the sewers are overcharged, and as they are very little below the basement level the water backs up in the cellars and basements. To provide increased capacity and at the same time to lower the present level of storm-water flow, the city proposes to build a large relief sewer in Monroe St., with 5-ft. branches north and south at ½-mi. intervals. This will have a capacity much greater than the combined capacities of the present sewers, which will be connected to it.

It was planned originally to run the Monroe St. relief sewer directly to the river, crossing the station property. But with the low elevation of the tracks, baggage subways, etc., in the station, the outlet would have had to be built as a siphon. The railways objected to this, as any failure or leakage would be likely to cause serious trouble. The plan was objectionable to the city also, as the siphon would flow full at all times so that inspection of its condition would be a difficult matter.

The plan decided upon was to divert the outlet around the station. As shown in Fig. 1, it will run north on Canal St. (the boundary of the station proper) from Monroe St. north to Washington St. (two blocks) and then run west to the river. Along Washington St. it will be built under private property just south of the street, in order to avoid the street-railway tunnel which passes under the river at that street. A branch in Clinton St. taps the Adams St. sewer.

This outlet, about 1,550 ft. in length, will serve as a substitute for the sewers that will be displaced by the construction of the new stations and yards, particularly between (and including) Madison and Van Buren St. In addition to serving as an outlet for these existing sewers, it will have sufficient capacity to carry flood water from the proposed relief sewer extending on Monroe St. west from Clinton St.

Double-Compartment Sewer Outlet

This relief sewer is designed to provide for a large and closely built up section of the city, and the outlet part has sufficient capacity to carry 500 cu.ft. per sec. without flowing full. At present only the outlet part will be built, with connections to the sewers whose outlets it will replace. Consequently the sewage flow will be small at first. The sewer is wide and the grade slight, and the elevation is so low that the outlet will be almost entirely submerged at all times. The railway tracks under which it passes are only 2 ft. above water level. Consequently there will be a very sluggish flow.

To provide for this condition and to give a minimum velocity of 1 ft. per sec. for normal flow, the outfall section along Washington St. (about 350 ft.) is designed as a double-compartment sewer (Fig. 3).

The new relief sewer in Monroe and Canal St. is of arched section, as shown, 12 ft. wide and 9 ft. high in inside dimensions. It will be about 1,200 ft. long. At the curve from Canal St. toward the river a division wall or weir will be built, about 5 ft. high and extending from the outer wall of the single sewer to the middle wall of the double-compartment section. This latter has rectangular compartments 8 ft. high, 5 ft. wide for the sewer proper and 7 ft. wide for the storm-water channel. The former will have capacity for a moderate amount of storm water, but with a heavy storm flow the excess water will flow over the weir and into the larger channel.

Where the sewer passes under the tracks, it was necessary to lower the roof, and the height is reduced to 7 ft. for the smaller and 6 ft. for the larger compartment. The greater height of the former is in order to maintain an air space for ventilation. This design puts the roof of the sewer channel at such a height that the track ties will be laid directly upon it. The width of this channel was therefore reduced to 3 ft. to permit a minimum thickness of roof, and a sharp descent is introduced in the invert grade of the sewer. This change of grade does not

greatly increase the velocity but provides against any check in the flow at this point.

There will be a concrete dock wall along the river front, and behind this will be chambers with grooves in the walls to permit closing the outlets with stop-logs. These chambers will be covered by removable slabs of reinforced concrete, to allow access.

The new outlet sewer on Fulton St. (Fig. 1) is 6 ft. in diameter, but in passing under the tracks the roof has to be lowered, so that it is little more than a semicircle 6 ft. wide and 4½ ft. deep. It is formed in a rectangular mass of reinforced concrete 9x7¼ ft. as shown by the section at the right in Fig. 3.

The W. J. Newman Co. is contractor for this outlet sewer. The construction of the arched sewer in Monroe St. for the one block between Clinton and Canal St. was carried on in an unusual manner. This block was closed to traffic and the entire roadway excavated between curb lines, by means of a revolving steam shovel, the cut being braced by heavy timber struts. The sewer was then built in open cut.

The invert was placed first, and then the steel forms of the Hydraulic Pressed Steel Co. were erected. They have steel ribs supporting steel panels (backed with wood) which are held in place by clamps. The concrete for the haunches was poured first, up to the level of the first row of braces. When this had set, these timbers were removed, and the concrete was carried up to the next row. Fig. 4 is an interior view. In the foreground there is only one row of braces, but farther back there are two rows.

The concrete for the work on Monroe St. was supplied from a portable steam-driven mixer stationed at the corner of the street, and was conveyed to the forms in wheeled carts. The backfilling was done by dump wagons, driving along the side of the cut. Some of these were of the drop-bottom type, and others were of a side-dump type rigged up by the contractor.

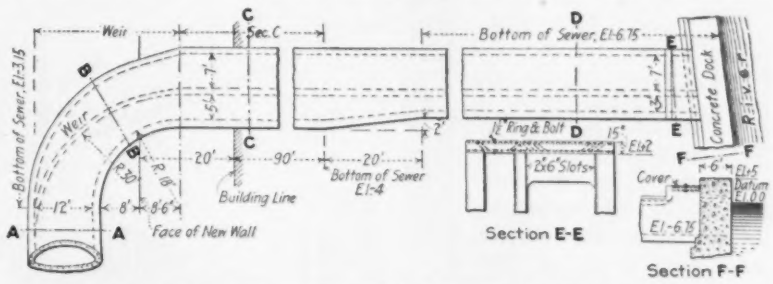

FIG. 2. PLAN OF MONROE ST. OUTLET SEWER, SHOWING WEIR AND DOUBLE-COMPARTMENT OUTFALL

As Canal St. has heavy traffic to and from the Union Station, it cannot be closed to traffic, and the sewer will be built in open cut beneath a temporary roadway. Previous to its construction a heavy retaining wall is being built in an open trench in the roadway (this wall being on the west line of the new station property).

Concrete for the wall and the sewer is delivered by a long line of spouting from a mixing plant with elevator tower. The tower and spouting equipment are of the Lakewood Engineering Co.'s type. This plant served not only for the sewer and retaining wall, but also for a part of the public-utility gallery built in connection with the new station (*Engineering News*, Dec. 16, 1915). It will serve also for other concreting on the station work.

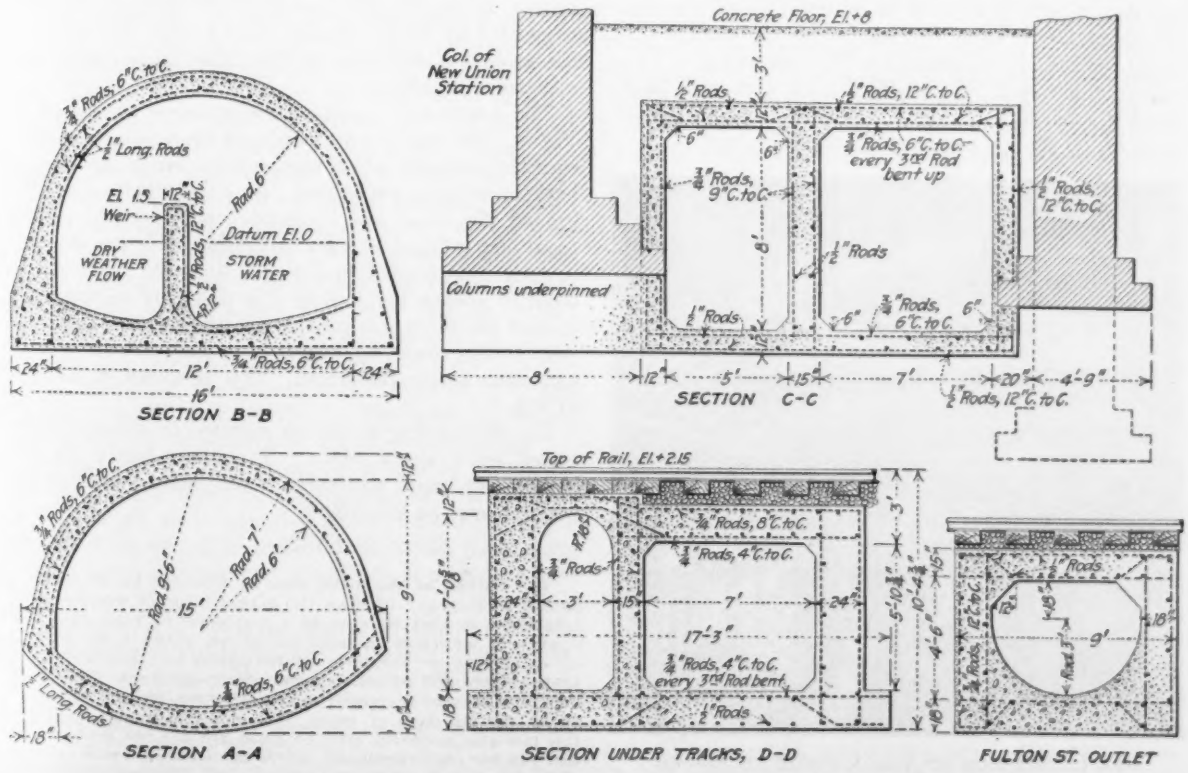

FIG. 3. CROSS-SECTIONS OF THE MONROE ST. OUTLET SEWER AT CHICAGO

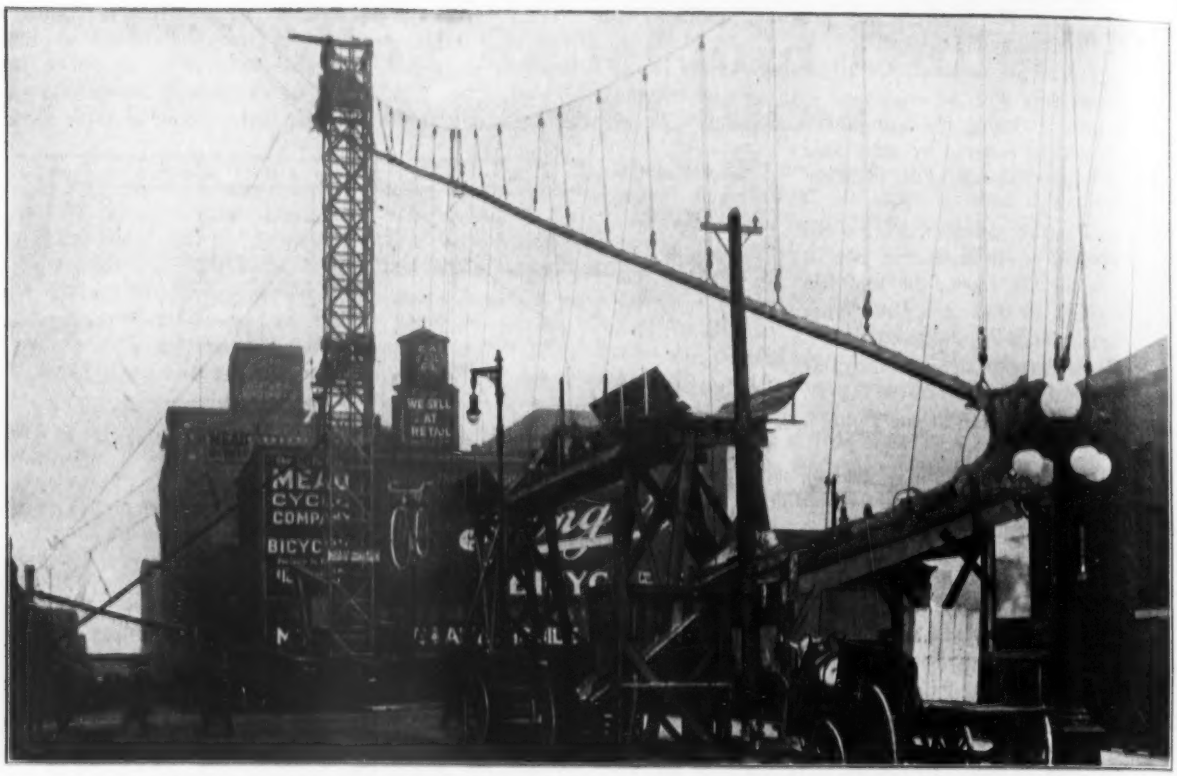

FIG. 5. CONCRETING PLANT ON CHICAGO SEWER WORK, WITH SPOUT 400 FT. LONG
The spout here shown is laid for only a portion of its length

The concrete mixing plant is located between Canal St. and the Union Station approach (Fig. 1), so that material is delivered by cars on a siding. Cement is handled in bulk, but has to be conveyed on wheelbarrows for about 20 ft. from the box car to the storage shed. From the shed it is delivered to the overhead bins by an elevating conveyor. A stiff-leg derrick with grab bucket unloads sand and stone from gondola cars and delivers them to the storage bins over the mixing plant.

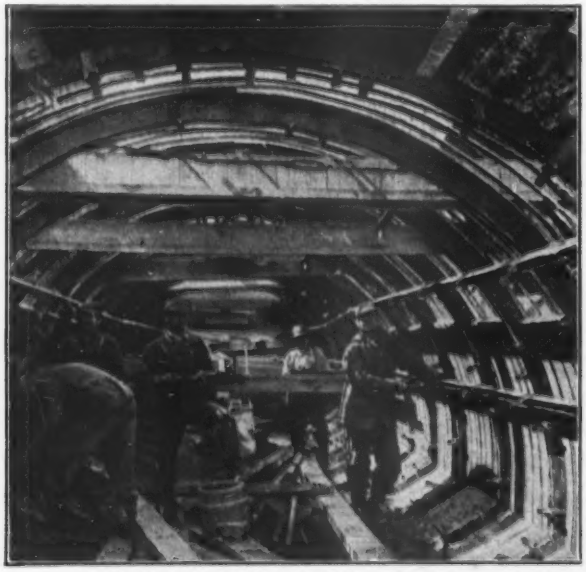

FIG. 4. INTERIOR OF THE MONROE ST. SEWER
The steel ribs carry steel panels for the forms. The timber trench bases are removed as the concrete is carried up

A ¾-yd. Chicago cube concrete mixer delivers the concrete to a bucket on an elevator tower 10x12 ft., 175 ft. high. At about 160 ft. above the street level is a hopper serving a line of steel spouting, 400 ft. long, which is suspended by hanger tackles from a cable leading from the tower to a braced post at the end of the baggage room, a distance of 500 ft.

The tower and a part of the spouting are shown in Fig. 5. The concrete is discharged through a cross-spout over the sidewalk into a hopper from which the wheeled buckets or carts are loaded. At about 65 ft. above the ground the tower has a second hopper serving a short spout across Canal St. Its suspension cable was attached to a tall post erected on the curb line. As there was no room to anchor the foot of this post very securely, the pull of the cable was resisted by bracing the top of the post to the tower by means of a long trussed timber extending across the street. This is shown at the left in Fig. 5.

The derrick and mixer are operated by steam engines, served by a single boiler. The tower has a Thomas electric hoist with winch heads for cables to handle the material cars on the siding.

The Spread of the 8-Hr. Day is indicated by an act just passed in Uruguay limiting the actual labor of workmen and employees in that country to a maximum of 8 hr. daily. It applies to workmen in factories, shops, yards, quarries, etc., to employees or servants of industrial or commercial establishments and of railway and street-car lines. The hours of adults may be increased in special cases, but not to exceed 48 hr. for six days of work. For every workman violating the law the employer will be fined $10 for the first offense and $15 for each repetition, while the workmen will be fined the amount received for the extra work. The law will go into effect in the latter part of February.

Lessening Cost of Valuation of Public Utilities*

By Leonard Metcalf†

Men of broad experience as members of public-utility commissions and staffs can save much expense and litigation in valuation and rate cases. Such men are able to arrive at results by methods of approximation, thus lessening the volume and cost of the evidence required from both the corporation and the public sides to the case. Where this breadth of experience is lacking, the evidence must be presented in far greater detail, coupled with comparative analyses of experiences had elsewhere, in the hope of making the force of the claims clear to the inexperienced reviewer.

In water-works valuation and rating cases the joint expenses of trial to the parties at issue have often amounted to from 10 to 15% of the total value of the property. Not only have courts, commissions and arbitration boards recognized the burdensome character of this expense, but also even the lawyers and experts. Conscientious effort has generally been made to eliminate by agreement, in advance of the trial, as many of the issues at bar as possible, with a view to decreasing unnecessary expense. Often it happens in court trials that while both parties may in good faith desire to bring about such agreement, the political situation may make it practically impossible to undertake it without incurring the danger of possibly having the subsequent decision called into question by reason of such joint effort. In these cases the public-utilities commissions are in a position to be of marked service to the parties at issue.

Innovations To Save Time and Expense

Some interesting and significant departures have been made from the ordinary legal methods of trial, with a view to decreasing the expenses involved in such litigation. Thus in the valuation of the water-works property of the Macon Gas Light and Water Co., the board of seven arbitrators, consisting of five engineers and two bankers, outlined and adopted the following course of procedure in the interest of economy of time and expense: (1) Counsel opened with a historic sketch of the situation; (2) the witnesses for the corporation and then for the city stated their qualifications, the nature and extent of their investigations, and their findings, briefly and without the intervention of counsel, either in direct or cross-examination; (3) counsel on both sides then discussed intangible or semi-intangible values; (4) any witnesses desired were recalled by the board at the request of counsel on either side, for cross-examination.

The program outlined proved acceptable to the parties at issue, and as a result of its adoption, the trial was concluded in a two weeks' period at a cost of about 3% of the amount of the award, instead of 15%, which might have resulted had the ordinary legal methods of procedure been followed.

More recently (1915) the Master in Chancery of the Federal Court of the District of California, Hon. H. M. Wright, in the trial of the Spring Valley Water Co. rating cases at San Francisco, modified the ordinary order and methods of court procedure. He heard all the evidence upon real-estate values before admitting evidence upon structural values. Next, taking up structural plant, all of the experts gave their evidence, simply and in the form of a connected story unaided by counsel, upon a single group of property, such as earth dams, or pumps, or conduits. Counsel was permitted to cross-examine the witnesses after the giving of this testimony and before taking up the next class of items. Incidentally the experts upon the one side were at liberty to question the experts of the other and to assist the court by statements of their own experience. The master has already given expression to the opinion that the time consumed has probably not been over one-third to one-half as great as it would have been if the ordinary methods of court procedure had been followed. Furthermore, it is believed that the master was thus put into the position to form judgment upon the various phases of the case under trial as the evidence was adduced and while the subject was still fresh in mind.

Limitation of Cross-Examination

In a recent hearing before Judge Sessions, at Grand Rapids (Ann Arbor vs. State of Michigan), the court limited the introduction of evidence and expenditure of time in the trial by limiting the cross-examination practically to questions touching upon the qualifications of the witnesses, their honesty of purpose, the soundness of the theories advanced by them and the major items entering into the estimates of the engineers—refusing to consider petty items as likely to have little effect upon the decision. The trial was concluded in six days, which is certainly a remarkably brief hearing for a case involving property values of ten million dollars, more or less.

Another departure that has been suggested is to be found in the appointment, by the court, of a disinterested engineer of experience to aid it in the formation of sound judgment; in effect calling the engineer to sit upon the bench with the judge to pass upon technical matters and to aid in limiting the lines of investigation to matters of fundamental importance and weight.

The observations here made upon court trials apply in some measure to trial by commission and serve to accentuate the desirability of having competent engineers as well as lawyers and business men appointed to our public-utilities commissions. The engineering, as well as the legal, point of view is of great importance in assisting to an expeditious and equitable solution of public-utilities problems.

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Political Changes in State Highway Departments were dealt with as follows by Logan Waller Page, Director of the Office of Public Roads, in a paper at the recent annual meeting of the American Association for the Advancement of Science: "Within the last 10 years arbitrary changes on political grounds have been made in the control of the engineering work in the state highway departments of Arizona, Connecticut, Delaware, Maine, Michigan, Maryland, Missouri, New Hampshire, New Jersey, New York, Pennsylvania, Washington and West Virginia. In the last 15 years nine changes have been made in the control of the highway department of New York, and most of these changes have been made on partisan political grounds." As the most effective way of protecting the state highway departments from politics, Mr. Page suggests that each department be placed under the control of a nonpartisan, unpaid commission. He would intrust to these commissions the selection of the chief technical road officers, their selection to be made wholly on the ground of qualifications as proved by competitive examination.

*From the Presidential Address to the New England Water-Works Association, Jan. 12, 1916. A section of the address relating to dangers of "Public-Utility Commission Control" was printed in "Engineering News" of Jan. 20, 1916.

†Of Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

Presidents of the Four National Engineering Societies

[With Portraits]

SYNOPSIS—Following the annual custom of "Engineering News" of 23 years' standing, there are published herewith portraits and brief biographies of the presidents of the four national American engineering societies.

E. L. Corthell; American Society of Civil Engineers

By Desmond Fitz Gerald*

Elmer Lawrence Corthell was born in South Abington, Mass., in 1840. In the middle of his course at Brown University, the Civil War broke out and he enlisted in response to President Lincoln's "Call to Arms." For more than four years he served continuously with the First Battery of Rhode Island Light Artillery and was promoted from the ranks to captain in command of a battery. Nearly all this time the battery was in active service in Virginia and North Carolina.

At the end of the Civil War he reëntered college and was graduated with the degree of bachelor of arts in the class of 1867. In 1868 he was given the degree of master of arts and in 1894 that of doctor of science, in recognition of his services in engineering. In 1867 Mr. Corthell entered the office of the Providence firm of Cushing & De Witt, Civil Engineers, at the same time with the writer, and unknown to each other both left for the West the following year. He entered the service of the Hannibal & Naples R.R. in Illinois as an assistant engineer. The following year he was made division engineer of 45 mi. of the Hannibal & Central Missouri R.R. Those were days of rapid promotion for young men of strong character and industry, and in 1870 Mr. Corthell assumed the responsible position of chief assistant engineer on the construction of a bridge across the Mississippi River at Hannibal, Mo.

In view of the long series of remarkable works with which he was associated, it seems wise to present them in the form of a concise list at the end of this sketch and to occupy the remaining available space in a general review of some of the more important of these works, together with a few words of appreciation of the man, his remarkable energy and endurance, which now, after a lapse of 75 yr., seem as effective as when he was at the zenith of his powers.

After several years' experience constructing bridges and levees, Mr. Corthell was chosen in 1875 by the late James B. Eads to take charge of the construction of the now famous jetties at the South Pass mouth of the Mississippi River. He was engaged in this work for four years. The results amply justified both Mr. Eads' and Mr. Corthell's faith and confidence in the success of the enterprise.

In 1877, when the American Society of Civil Engineers held its annual convention in New Orleans, a memorable excursion was made to these jetties. In this excursion the writer was invited to participate; he will never forget the trip by steamer from New Orleans 100 mi. down the river; the arrival at night; the attack by numerous swarms of mosquitoes; the final flight of the steamer to midstream, to save the lives of the party; the reception by Mr. Corthell; his active efforts to give all a comprehensive idea of the methods of construction; the passage into the Gulf; the phenomena of "mud lumps," and the return by the Southwest Pass.

Soon after the completion of the jetties followed the project of the Tehuantepec ship railway, into which Mr. Corthell entered with enthusiasm. After the plans and models were prepared, in order to enlighten the public, expositions and addresses were made in many cities. After this work came Mr. Corthell's partnership with the late George S. Morison, in 1887, for the construction of important bridges over the Ohio and Missouri Rivers. In 1889 Mr. Corthell was Chief Engineer of the St. Louis Merchants' bridge over the Mississippi River, and at the same time he was engaged in other important undertakings such as jetties at the mouth of the Brazos River, in Texas, and at the mouth of the Panico River, at Tampico, Mex. Upon the latter work he was engaged for several years, and in 1895 his paper presented before the Institution of Civil Engineers describing these works won for him the Telford premium and the Watt medal.

Following these events came important commissions from the Argentine Republic and Brazil, principally in connection with harbor works, and these brought wide reputation and many honors. During his career Mr. Corthell has been a deep student of professional and educational problems in Europe and the Americas. He has written voluminously and effectively; the bibliography of his publications embraces more than 60 titles.

His kindly disposition and wide sympathies have brought him many friends, and now his selection as President of the American Society of Civil Engineers adds still another field for his unwearied activities.

Mr. Corthell is an active or honorary member of many engineering and scientific societies, among which are the Canadian Society of Civil Engineers, the Institution of the Civil Engineers of Great Britain, the Society of Arts of Great Britain, the French Society of Civil Engineers, the Mexican Association of Civil Engineers and Architects, the Engineering Society of Portugal, the Institution of Engineers of the River Plata.

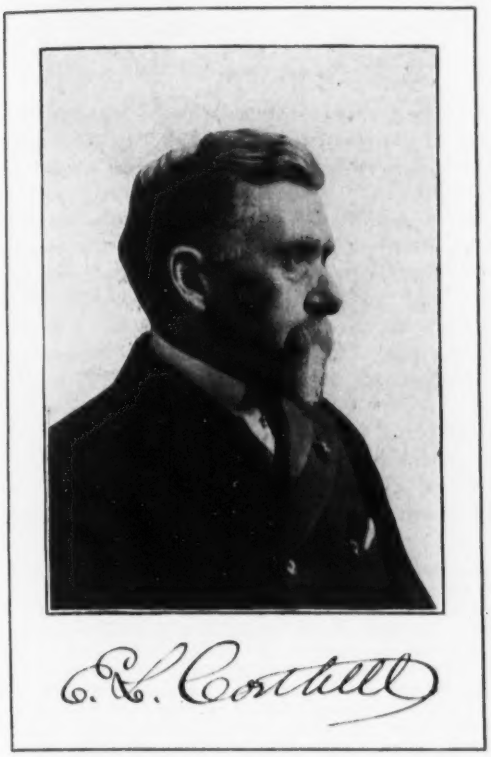
The principal works on which Mr. Corthell has been engaged are as follows:

Harbor Works—1875-80, Mississippi jetties; 1880-87, Tehuantepec ship-railway project; 1889-90, jetties, Brazos River; 1889-92, jetties, Tampico, Mex.; 1900, consulting engineer for Argentine Government on river and harbor work, Buenos Aires; Congress at Paris, paper on "Ports of the World"; 1902, president of Board to Report Plans for Port of Rosario; 1903-05, Works in Brazil, Buenos Aires, etc.; 1904, Advisory Board on Barge Canals for the State of New York.

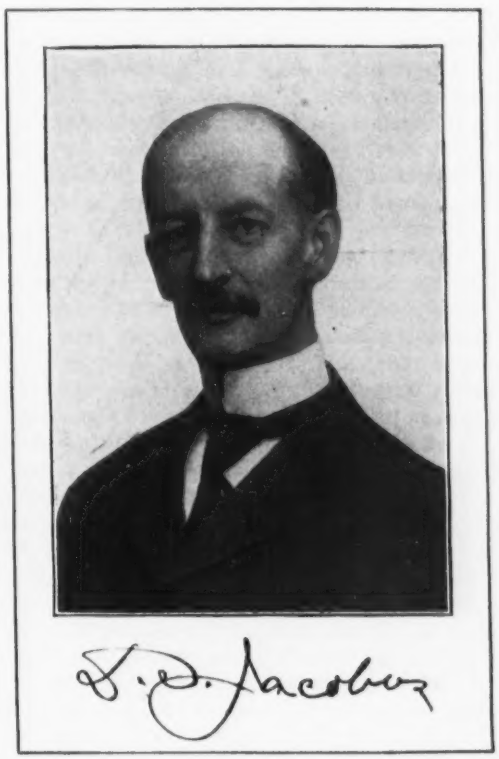
Bridges—Ohio River at Cairo; Missouri at Nebraska City and at Sioux City; St. Johns at Jacksonville; Mississippi River at St. Louis and the New Orleans project.

Railroads—1881-85, New York, West Shore & Buffalo, Ontario & Western; 1890-93, "independent entrance" of railways into Chicago; 1892, Mexican National; Tehuantepec; rapid-transit and railroad problems in New Orleans, Atlanta, Montgomery, Chicago, Buffalo, Memphis and City of Mexico

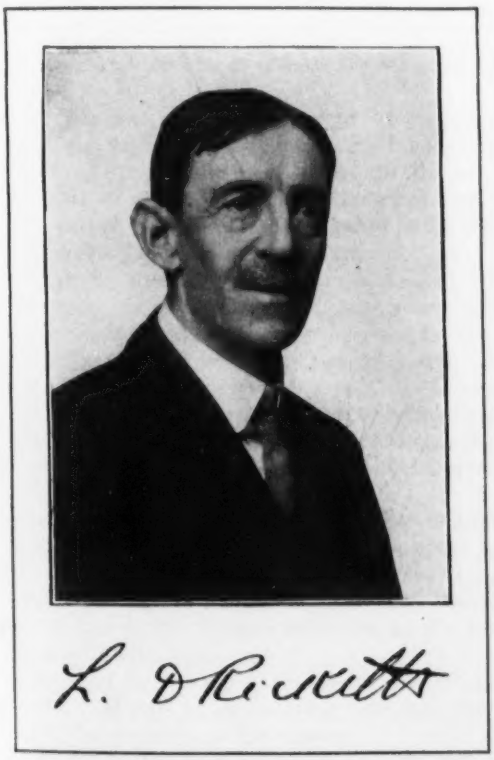
*Consulting Engineer, Brookline, Mass.



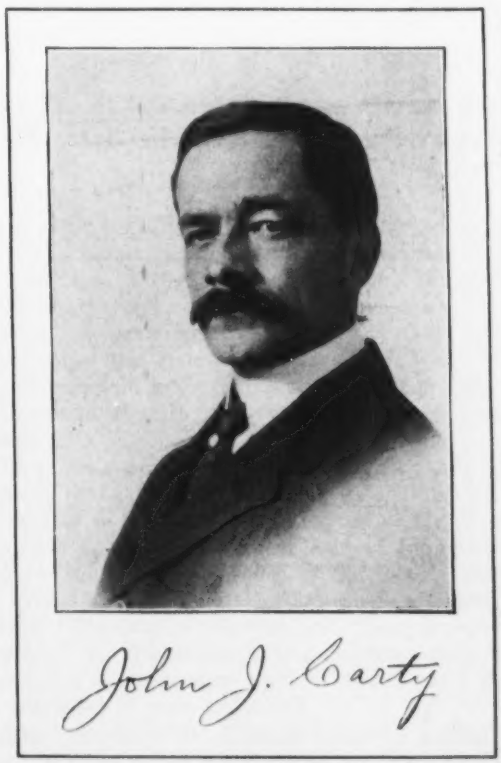
PRESIDENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS



PRESIDENT OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



PRESIDENT OF THE AMERICAN INSTITUTE OF MINING ENGINEERS



PRESIDENT OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE PRESIDENTS OF THE FOUR NATIONAL ENGINEERING SOCIETIES

D. S. Jacobus; American Society of Mechanical Engineers

By William Kent*

David Schenck Jacobus was born in Ridgefield, N. J., Jan. 20, 1862. He is of Dutch descent, one of his ancestors having been among the first settlers of northern New Jersey prior to the year 1675. He was educated in a private school conducted by the Rev. A. B. Taylor, a venerable country pastor who for many years presided over the old Dutch Reformed Church at Ridgefield; then he entered Stevens High School, Hoboken, N. J., where he won, by a competitive examination, a free scholarship in the Stevens Institute of Technology. He was graduated from the institute in 1884 with the degree of mechanical engineer.

Upon his graduation he was appointed instructor, then assistant professor of experimental mechanics, being closely associated with Prof. J. E. Denton. In the *Stevens Indicator* of January, 1887, Professor Denton wrote of him:

> Mr. D. S. Jacobus was chosen three years ago as assistant in the department of experimental mechanics, because his career as a student had shown him to be possessed of unusual analytical powers, combined with sagacity and skill in executing experimental work, which were deemed an essential prerequisite in a chief assistant in the plans for the development of this department. Such forecasts of his special abilities have not only been amply fulfilled during the three years which have since elapsed, but a capacity for the performance of routine work has been shown which apparently defies fatigue. Mr. Jacobus, besides managing the experimental work carried on by the senior class during the preliminary terms, has taught the classes in molding, blacksmithing and pattern making; he has carried on most of the detail testing work in metals, oils, power, etc., and has still found time to assist in some important details in the arrangement for experimental investigation, often at localities remote from the institute, made by students as a basis for their graduating theses.

In 1897 he was called to the chair of experimental mechanics and engineering physics, in which he continued until 1906. From 1900 to 1906 he was also in charge of the construction of the Carnegie Laboratory of Engineering, built and equipped with funds donated to the Stevens Institute of Technology by Andrew Carnegie.

While at the institute Dr. Jacobus performed a large amount of expert work involving investigations and reports upon mechanical devices and processes for the production of power and efficiency tests on steam motors, turbines and other power-plant apparatus. He was among the first in the field of refrigeration, making tests of machines and writing articles on the subject. He also made early experiments on acetylene gas generators and on fire-sprinkler systems.

During these years he made numerous contributions to the literature of engineering, averaging about four papers a year. Most of his printed papers are found in the "Transactions" of the American Society of Mechanical Engineers and in the *Stevens Indicator,* of the Stevens Institute of Technology.

As a teacher he was highly successful, and more than a thousand students of engineering have had the good fortune to be members of his classes.

Since 1906 he has been associated with the Babcock & Wilcox Co., boiler manufacturer, at the head of its engineering department in the capacity of advisory engineer. This connection made it necessary for him to give up practically all his work at Stevens Institute, although he continued on the faculty as a special lecturer in experimental-engineering and steam-engineering subjects. At the same time, in 1906, the institute conferred upon him the honorary degree of doctor of engineering and elected him a member of the Board of Trustees.

He was elected to membership in the American Society of Mechanical Engineers in 1889; he was manager of the society from 1900 to 1903 and was vice-president from 1903 to 1905. He was a member of the committee which framed the present constitution and was chairman of the committee appointed to standardize a system for testing steam engines. This committee presented its final report in December, 1902. In 1903 he was appointed chairman of a committee to suggest a standard tonnage basis for refrigeration, and in 1910 was chairman of the committee on power tests. Owing to the pressure of business duties he resigned the chairmanship, but he took an active part in the preparation of both the preliminary and the final reports. In 1914 and 1915 he served as a member of the boiler-code committee.

Dr. Jacobus is also a member of the American Institute of Mining Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers, and a fellow of the American Association for the Advancement of Science. He was president of the American Society of Refrigerating Engineers in 1906-1907. He is a member of the American Mathematical Society, the Society for the Promotion of Engineering Education, the American Society for Testing Materials, the Franklin Institute of Pennsylvania, the Engineers' Club and the Holland Society of New York City.

*Consulting Engineer, Montclair, N J.

L. D. Ricketts; American Institute of Mining Engineers

By Palmer C. Ricketts*

Louis Davidson Ricketts was born in Elkton, Md., Dec. 19, 1859. He was graduated from Princeton College in 1881 with the degree of bachelor of science. His specialty was chemistry, and when he was graduated, a fellowship in chemistry was given him for the year 1882. At the expiration of this time he won the W. S. Ward fellowship in economic geology, thus remaining one more year and leaving college in 1883 with the degree of doctor of science.

One of the conditions of the award of the Ward fellowship was that the student receiving it should spend half of the year in mines under the control of Mr. Ward in Leadville, Colo., and the other half in theoretic work at Princeton. In consequence of the former provision Mr. Ricketts wrote for his doctor's thesis a dissertation, entitled "The Ores of Leadville and Their Mode of Occurrence," so remarkable in its character that copies were called for from many parts of America and Europe for a number of years afterward.

After graduation Dr. Ricketts became a mining engineer. He was surveyor and superintendent of Colorado mines from 1883 to 1887. In 1887 he became state geologist of Wyoming, remaining in this position for a

*Director, Rensselaer Polytechnic Institute, Troy, N. Y.

period of three years. He was consulting engineer for Phelps, Dodge & Co. for their mining interests in the Southwest from 1890 to 1906. During this period he designed and built the following works: In 1898, a concentrator of 400 tons' daily capacity for the Detroit Copper Mining Co. at Morenci; in 1899-1901, as general manager of the Moctezuma Copper Co., concentrators and smelting works at Nacozari; in 1903-05, concentrators for the Cananea Consolidated Copper Co., and in 1903-06, as general manager of the Old Dominion Copper Mining and Smelting Co., concentrators and smelting works at Globe, at the same time reconstructing and reopening the mines of the company at this place.

Since 1906 Dr. Ricketts has been president and general manager of the Cananea Consolidated Copper Co. and consulting engineer for the Anaconda Copper Mining Co., the Inspiration Consolidated Copper Co., the International Smelting Co., the Arizona Copper Co., the Calumet & Arizona Mining Co., and the New Cornelia Copper Co. During this time he has reconstructed the reduction works and reorganized the mines of the Cananea Consolidated Copper Co., remodeled the concentrators and built new smelting works for the Arizona Copper Co., and acted as consulting engineer in building new smelting works for the Calument & Arizona Mining Co. and the International Smelting Co., the latter having a capacity of 16,000,000 lb. of copper a month. An important part of his work during this period has been that done for the Inspiration Consolidated Copper Co. for which organization he has acted as consulting engineer in the development of its mines and the building of its concentrator of 14,000 tons' daily capacity, in which flotation of copper ores was introduced for the first time on a large scale.

During the past 12 yr. Dr. Ricketts has, in construction of works alone, directed the expenditure of between $35,000,000 and $40,000,000 and has been identified with, and in no small degree responsible for, the great decrease in unit costs and the great increase in recoveries which have so greatly extended the reserves of commercial copper ore in the United States. At the present time he is identified with a process for leaching oxidized copper ores and recovering copper from the resulting solution by electrolytic precipitation, for the New Cornelia Copper Co. This company is about to erect an initial plant of 4,000 tons' daily capacity.

Dr. Ricketts has had many interests besides those directly connected with mining. He is president of the Tucson, Cornelia & Gila Bend R.R. Co. and of the Morenci Water Co. at Morenci, Ariz., and vice-president of the Gila Valley Bank and Trust Co. and of the Valley Bank at Phoenix, Ariz. He is a member of the American Society of Civil Engineers and of the Institution of Mining and Metallurgy of Great Britain. In 1913 he received the gold medal of this institution for a paper on "Reverberatory Smelting." He is a member of the Engineers' Club and the University Club of New York City.

In 1912 he was elected a trustee of the University of Arizona. When, at the request of the directors of the 1915 Pan-American Exposition, the governor of the State of Arizona appointed a committee to select a man from that state as its most distinguished citizen, Dr. Ricketts was chosen by the committee and received from the exposition a medal in commemoration of this fact.

J. J. Carty; American Institute of Electrical Engineers

By Charles W. Price*

John J. Carty is the twenty-eighth President of the American Institute of Electrical Engineers, and the second chosen from the telephone industry, the first being Dr. Alexander Graham Bell, the inventor of the telephone.

Mr. Carty was one of the first to appreciate the possibilities of the telephone, and soon after it was invented he entered the service of the Bell Telephone System, where he has been continuously employed in the development of the telephone art for more than 35 yr.

His first work was at Boston, and while there he made a number of contributions to the art of telephony which were of unusual value and have since become a permanent part of the art. For the "express" telephone system, peculiar to that city, he designed and installed a switchboard which was the first metallic-circuit multiple board to go into service.

In 1887 Mr. Carty took charge of the cable department of the Western Electric Co. in the East, with headquarters at New York. In this capacity he studied cable manufacture and laying and introduced a number of improvements, having charge of all of the important cable-laying projects which were carried on at that time in the East. One of his engineering developments resulted in cutting in half the cost of cable manufacture. He then took charge of the switchboard department of the Western Electric Co., for the East, and under his direction were installed most of the large switchboards of that period. During this time he made a number of important improvements in switchboards, which have since become standard practice.

He was the first to demonstrate practically how to operate two or more telephone circuits connected directly with a common battery and about 1888 installed, for the supply of operator's telephones, common battery systems in a number of central offices. From these early experiments has grown the modern system now generally employed.

Although charged with serious practical engineering problems, Mr. Carty has found time to follow to some extent his strong natural inclination for original research. He made an exhaustive investigation into the nature of the disturbances to which telephone lines are subjected and gave the first public account of his work in a paper entitled "A New View of Telephone Induction," read before the Electric Club on Nov. 21, 1889. The view put forth in the paper was revolutionary but nevertheless, after being checked by numbers of experimenters in this country and Europe, received universal acceptance. In this paper he showed the importance of electrostatic induction as a factor in producing cross-talk and proved that under certain conditions there is in a telephone line a particular point in the circuit at which, if a telephone is inserted, no cross-talk will be heard. The paper gave directions for determining this silent, or neutral, point and described original experiments showing how to distinguish between electrostatic and electromagnetic induction in telephone lines.

On Mar. 17, 1891, Mr. Carty made additional contributions to the knowledge of this subject in a paper

*Editor, "Electrical Review," Chicago, Ill.

fore the American Institute of Electrical Engineers, entitled "Inductive Disturbances in Telephone Circuits." This paper might better have been called "The Theory of Transpositions," because in it was first made known precisely why twisting or transposing telephone lines renders them free from inductive disturbances.

In 1889 he entered the service of the Metropolitan Telephone and Telegraph Co., now the New York Telephone Co., for the purpose of organizing all of the technical departments, building up its staff and reconstructing the entire plant of the company—converting it from grounded circuits overhead and series switchboard to metallic circuits placed underground and to the then new bridging switchboards. In carrying out this work he selected and trained a large staff of young men fresh from college, many of whom have since attained positions of eminence in the telephone field.

While for many years Mr. Carty's work was more particularly directed to the extraordinary problems of telephony presented by the great centers of population, it remained for him to accomplish a revolution in telephony of the greatest social and economic value to rural communities in all parts of the world. Prior to his work upon the subject, the number of telephone stations which could be operated upon one line was limited and the service was imperfect. As a result of his solution of a problem presented by the New York Central & Hudson River R.R. in the City of New York, he devised a mechanism known as the "bridging bell," whereby any number of stations, even as many as a hundred, might be placed upon a line without in any way impairing the transmission of speech. This made possible the farmers' line, which is found by the hundreds of thousands in farmers' houses in America and is now being adopted in rural districts all over the world. For this achievement he received from the Franklin Institute the Edward Longstreth medal of merit.

Since 1907 Mr. Carty has been chief engineer of the American Telephone and Telegraph Co., in which capacity he is responsible for the standardizing of methods of construction and operation of its vast plant, which extends into every community of the United States and which, through its long-distance wires, extends into Canada and Mexico. Under his administration the country-wide engineering organization of the Bell system has been built up to the highest state of efficiency.

During the year just past, the engineering force, acting under his command, has successfully established telephone communication across the North American continent from the Atlantic to the Pacific by means of the transcontinental telephone line and has established telephone communication without the use of wires from Arlington, Va., across the Atlantic Ocean to Paris, on the east, and across the continent to San Francisco and over the Pacific to Honolulu. Of these two the transcontinental line only is now open for commercial use.

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Cleaning Up After Snowstorms in Philadelphia

By William H. Connell*

SYNOPSIS—How one large American city organizes to dispose of snow on busy streets.

The main idea in a snow-removal organization is preparedness. In Philadelphia, at any hour of the night, as soon as the snow starts to fall, the Electrical Bureau notifies the chief of the bureau and the engineers in charge by telephone, in their respective homes. One engineer living in the central part of the city is in constant communication with the United States Weather Bureau and the Chief of the Bureau of Highways. As soon as the indications point to a continuance of the storm, the snow-fighting equipment is ordered out, about one thousand telephone messages being sent to various parts of the city to call out squad leaders, inspectors, snow plows, drivers, teams, laborers and officers in the various police districts, who aid in getting out the men.

In about one hour after the order is given, the horse-drawn plows and motor-driven plows attack the snow in the central business section of the city. These plows are supplemented by an army of laborers and teams who keep constantly at work day and night shoveling and dumping the snow into sewer manholes and the Delaware and Schuylkill Rivers.

Every man in the snow-removal organization has a particular function assigned to him. For instance, each dump inspector knows his post is at a certain dump, and he knows just what to do when he gets there; the driver of every snow plow and of every team knows where he is to report, at what point he is to start to load and at what sewer manhole or wharf he is to dump his loads, and there is no confusion.

Fighting the snow at night during some of the storms we have had in the past three years is no easy task for the Highway Bureau engineers assigned as squad leaders, the inspectors and the laborers, and it requires the constant presence of the chief of the bureau and his principal assistants to encourage the men and stir up the necessary enthusiasm to keep the work going.

In the central business section of the city, snow is removed from all the thoroughfares. This work is performed under special contracts supplemented by the regular street-cleaning force and is under the supervision of a special snow-removal organization made up of men assigned to this work from the regular engineering staff.

Certain main thoroughfares and all the street crossings throughout the entire city are also cleaned by the regular street-cleaning forces and the large municipal force assigned to the seven highway district engineers who supervise this work. A large force is always employed opening up the country roads, where the drifts often completely block traffic. All told, the force employed in snow removal ordinarily consists of about 4,000 men, 1,200 teams and the advance guard of 38 horse-drawn and 20 motor plows.

*Chief of the Bureau of Highways, Philadelphia, Penn.

During the daytime the mobilization of the snow-fighting forces is comparatively an easy matter as compared with turning out this force at night, but as the main idea is preparedness in the work of snow removals, the organization has been instructed in the methods that under the circumstances would seem to be best adapted to prevent interruption to traffic during and after a snowfall. It is practically impossible to get a large number of laborers to work at night during a very severe storm. To offset this, great stress has been laid on the use of the snow plows to keep the streets open to traffic.

Whenever the storm occurs in the daytime, or at night when the weather conditions are not too severe, considerable of the work is performed by flushing, sweeping and shoveling the snow into sewer manholes and inlets.

FIG. 1. BROAD ST., PHILADELPHIA, AFTER SNOWSTORM, SHOWING FIRST STAGE OF SNOW REMOVAL

This method, however, could not be depended upon in a storm such as the blizzard of February, 1913, as it would be practically impossible to get a sufficient labor force to work to keep the streets open to traffic under such severe conditions as existed the first night of the blizzard. It is for this reason that every effort is used to keep the plows constantly at work pushing the snow to the side of the street during the progress of the storm. This system had enabled us to keep the streets open to traffic when we have had difficulty with the labor situation.

There has never been very great difficulty, however, in getting enough laborers and teams in the daytime or at night to load into the wagons the snow piled at the side of the street and haul it to the dumps, but it is planned to depend entirely upon getting sufficient laborers to dispose of the snow by shoveling it into sewer manholes. This feature of the work is simply supplemental to the main feature, which is the use of the plows to keep the streets open to traffic. After four years' experience with this method, we have concluded to increase the number of snow plows and place the main dependence upon them, as it takes very little time to get them on the work and it is possible to keep them at work at all times, even during the most trying conditions.

Early in the fall of each year the several division engineers and district assistant engineers are required to prepare a complete assignment schedule for all of the forces under their supervision. This schedule constitutes a program of proposed operations, includes a definite assignment for each individual employee or gang and indicates in detail the point to which each member of the force is to report and just what duties each is to perform.

The squad leaders are required to acquaint themselves fully with the traffic conditions existing in their respective snow-removal districts and with the location and character of the assigned dumping places, the character of and the storage location of the contractors' equipment, and the names and call addresses of both the contractors and the inspectors assigned to their respective squads. They are also required to see that their inspectors and contractors are thoroughly instructed in their respective duties, so that there will be no possibility of misunderstanding any detail of the work.

All of the employees assigned to snow-removal work understand that they are subject to call at any hour of the day or night, and in case of absence from their scheduled call address they are required to make suitable arrangements for immediately receiving any notice or order to report that may be sent them. Each gang foreman is also made personally responsible for the notification and reporting on the work of a selected number of the regular municipal laborers living in his locality.

To insure the efficient operation of the snow-removal work, the instructions and forms noted on the next page and illustrated on page 224 have been provided.

FIGS. 2 TO 6. TYPES OF SNOW PLOWS USED IN PHILADELPHIA SNOW REMOVAL

Fig. 2—Eight-foot wing plow on trolley car. Fig. 3—Motor-truck plow. Fig. 4—Scraper attached to automobile tractor Fig. 5—Scoop shovels for piling snow and dumping into manholes. Fig. 6—Horse-drawn scrapers operating in battery

(a) A set of detailed instructions which definitely indicate to the persons supervising the work the nature of the work to be done and the methods to be used in its performance.

(b) A map indicating the highways included in each of the 19 central snow-removal districts, and the nature and exact location of the snow dumps.

FIG. 7. LOADING WAGONS WITH SNOW FROM WINDROWS LEFT BY PLOWS

(c) An organization schedule indicating the name, call address, telephone number and the assignment of each person detailed to snow-removal supervision.

(d) Tickets of distinctive colors for loading and dumping respectively.

(e) Ticket-issue records.

(f) Current status of work records.

(g) Squad leaders' daily reports.

(h) Squad leaders' daily-report summary.

The central business section is divided into 19 districts, each district being under the supervision of a squad leader to whom is assigned a number of inspectors, some of whom supervise the removal of the snow, while others see that it is properly disposed of at the dumping places.

Duties of the Inspectors

The inspectors supervising the snow removal see that the snow is properly plowed into windrows adjacent to the curb, then piled and hauled to the dump. They are also required to measure and calculate the cubical capacity of all hauling vehicles and see that these vehicles are properly loaded, after which they give the drivers loading tickets, which are exchanged at the dump for another ticket which is retained by the driver and upon which payment is made.

The inspectors at the dumping places are required to see that the snow is properly dumped and that no improper material likely to obstruct the sewer is mixed with the snow. In the sewers where there is not a sufficient flow of water a water jet has been provided, which serves to increase the flow in the sewer.

Bureau of Highways and Street Cleaning Department of Public Works City of Philadelphia	SQUAD LEADER'S DAILY REPORT ON SNOW-REMOVAL WORK	District No. Division No.

Plowing Forces / Removal Forces	Ordered to Report For Duty	A.M. / P.M. / A.M. / P.M.	Reported on the Work	A.M. / P.M. / A.M. / P.M.	Number on Tickets Issued	Loading	Dumping

Work Performed on this Date

Character	On	From	To	Quantity Loads	Quantity Cu.Yd.

Force Employed on this Date — Inspectors

Labor and Equipment	Number	Hr. Worked	Force Hr.	Name	Assignment	Started	Stopped	Hr.
Foremen								
Laborers								
Horse-plow outfits								
Horse-scraper outfits								
Motor-plow outfits								
Double teams								
Motor trucks								

Contractor: Name

Weather conditions — Temperature: Minimum — Maximum

Delays: Reason and duration

Instructions received from assistant engineer

Times: of your reporting on this work — Commencement — Completion

Remarks

Date of this report — Submitted by — Approved by

.....191 ..... Squad Leader ..... Division Engineer

FIG. 8. SQUAD LEADER'S DAILY REPORT ON SNOW-REMOVAL WORK

Bureau of Highways and Street Cleaning Department of Public Works City of Philadelphia	CURRENT-STATUS RECORD OF SNOW-REMOVAL OPERATIONS	District No. Divisions No.

Reported at		Force at Work											
		Labor			Equipment						Progress and Conditions	Reported by
Date	Time	Foremen	Laborers		Horse-Plow Outfits	Horse-Scraper Outfits	Motor-Plow Outfits	Double Teams	Motor Trucks			

FIG. 9. HEADQUARTERS RECORD OF THE STATUS OF SNOW-REMOVAL WORK; PHILADELPHIA BUREAU OF HIGHWAYS

All inspectors on both the loading and the dumping work are required to see that the work is performed in such manner as to entail the least possible interruption to traffic.

After beginning operations, each squad leader makes to the main office hourly reports of the labor force and equipment on the work, and also of the general conditions existing in his district. These reports are entered on the current status of work record (Fig. 9), which greatly assists in the administration of the work. Each squad leader is also required to make a daily report which indicates in detail the character and quantity of the work performed, the force employed and other details.

The highly satisfactory results produced through the operation of the snow-fighting forces under this system in the past several years have proved conclusively that the efficient administration of snow-removal work is fundamentally a matter of preparedness based upon an exhaustive study of the requirements of the work, the establishment of a proper organization, the provision of a definite and adequate procedure, and the thorough instruction and drilling of the snow-fighting forces in the requirements of their respective duties.

River and Harbor Appropriations by the Federal Government from the time since it began work on waterway improvements to and including the appropriation bill of Mar. 4, 1915, have amounted to $853,757,950, according to the annual report of the Chief of Engineers. During the fiscal year ending June 30, 1915, the total of Federal expenditures on river and harbor work was $43,771,509. In addition the Government expended on river and harbor work $1,558,278 contributed by states, municipalities and private parties.

Land-Drainage Administration

Important improvements in the Michigan drainage law are suggested in a recent report on drainage in the southern part of that state, by A. D. Morehouse, Drainage Engineer, Office of Public Roads and Rural Engineering, Department of Agriculture, Washington, D. C.

The county drain commissioners are elected by the people for two-year terms, but the office is largely political, the salary is low, and the term too short. The report suggests that the salary should be commensurate with that of the highest-paid county officers and that the law should set a minimum salary. "An engineer or a man of some engineering knowledge would be very desirable for the position, as, primarily, all drainage problems are of an engineering nature."

In handling drains involving more than one township, the combined township boards form too cumbersome an organization, and it would seem proper that the drainage commissioner be authorized to act in all cases, instead of the township board.

Need for a Drainage Engineer

The position of the drainage engineer and his relation to the drain commissioner are very important. But in many cases the necessity of a competent engineer to make a real drainage survey, to plan the system and to superintend its construction has not been realized. In securing the courses and distances and possibly a few levels, it was felt that the "engineering" for the drain had been completely carried out. The feeling seems to be all too common that the engineer is but a "hired man" to put the ditch where told and to make it of such size, shape and grade as may suit the peculiar idea of some landowner or drain commissioner, irrespective of its efficiency as a ditch.

In many cases the greatest part of the time and care was taken in carrying out the legal details, and too little attention was paid to properly locating or designing the drainage system. The engineer should be intrusted with all the engineering features of the project, including the plans, profiles, specifications and estimates of cost; and he should be one of the board to assess the benefits.

The standardization of drainage work throughout the state and the obtaining of the greatest results for the money expended would be attained in the best way by the employment of a state drainage engineer, whose office would be available for consultation on all drainage matters by the county drain commissioners and drainage engineers of the state. When called upon, he should pass upon the plans of drainage districts, in which case his recommendations should be obligatory. He should formulate and simplify, so far as possible, drainage methods and procedure for the state.

The sale of the drainage bonds would be greatly facilitated by the approval of such a state officer, even though they were not guaranteed by the county and state. In many districts the drainage work to be undertaken may materially affect the flow of the streams of the state, with the possible danger of increasing flood discharge. The engineer of the district and the county drain commissioner have local interests to conserve, and their jurisdiction does not extend beyond the particular district.

Mr. Morehouse concludes, therefore, that Michigan needs a competent drainage engineer with authority to pass upon such matters, one who will have a thorough grasp of the large needs of the state in drainage and in flood prevention and control work.

Seemingly, drainage in southern Michigan has been subservient to water-power development, as indicated by the thousands of acres of marsh or other wet land impossible of drainage at present on account of the damming of the streams. In the design of drainage works it is often possible to protect or develop water power, especially in the larger streams, without detriment to the drainage reclamation undertaken. There are likewise possibilities for irrigation works which may prove of great value in the development of the truck-farming and special-crop industry. Such matters can be satisfactorily handled only by some state official vested with the proper authority.

The law should authorize the formation of drainage districts, with corporate powers, as political subdivisions of the state, each such district to be officered by specially elected commissioners or each county to have a board of drainage commissioners to act for all districts formed in the county. In the latter case the county drain commissioner should be president of the board.

Drainage districts should have authority to issue drainage bonds to pay for the entire cost of the district except maintenance of drainage works. Such bonds, before issuance, should be guaranteed and registered by the county or by the state; in large districts or multi-county work the state should guarantee the bonds. The present method of paying for drainage work in not more than four annual tax payments often either prevents the construction of large drainage works or makes them an excessive hardship to the landowner.

The issue of "drain orders," which in many cases have been repudiated and which seldom sell at less than 7% discount (and sometimes up to 13 or 15% discount for one-year paper or less), is not conducive to obtaining the lowest bids from contractors or the most work for the money expended.

Layout and Maintenance of Drainage Systems

Piecemeal drainage should be discouraged. But comprehensive drainage systems covering entire drainage units, with mains and laterals, should be encouraged to the greatest possible extent by the county drain commissioner, who should be familiar with all the drainage conditions of the county and do everything in his power to encourage drainage, as the county highway commissioner is expected to do in the interest of the roads. To this end the commissioner should, upon the recommendation of the engineer, decide the proper points of beginning and ending of a ditch, its size, grade, side slopes, laterals, etc.

The law should compel the maintenance of all drains or drainage systems, and it should be the duty of the drain commissioner to have an annual maintenance tax levied on all of the benefited lands as originally assessed. Under the present law, in order to maintain, clean out, enlarge or extend a drain, it is necessary for the landowners to circulate and present an entirely new petition, which must go through a routine similar to that for the original petition. The result is that a great many drains are either greatly in need of repair or are practically inoperative through failure of the landowners to go to the extra trouble involved in such cumbersome routine.

Field and Office

Ditching with Capstan Plows

For excavating the smaller sizes of farm ditches, too small for the use of the floating dredge or the land dredge, a ditching plow was invented about 40 years ago in western Indiana. It had a double moldboard and cuts a ditch about 4 ft. wide on top and 2 ft. deep, with a bottom width of less than 1 ft. To draw this plow, 80 oxen were used, making the ditch at one cut.

The next step in the development of this type of ditching machine was to pull the plow with home-made wooden capstans and manila rope. Later, wire rope was used, with larger capstans of steel and wood having self-anchoring devices. Horses were used to haul the outfits and to turn the capstans. As more powerful pulling equipment was developed, the plows were enlarged and built of steel. This type of ditching machine finally developed into a standard outfit, consisting of one plow and two capstans, using several thousand feet of steel cable with each rig.

Work of the Horse Capstan Plows

With this outfit the plow will cut a ditch 8 ft. wide on top, 18 in. on the bottom and about 3 ft. deep. It is drawn by two ¾-in. steel cables, one from each capstan, both being operated at the same time. It makes a ditch with one cut in land either dry or under water and places on both sides of the ditch the earth excavated, pushing the earth back so as to leave a clean berm of 3 ft. The two capstans used to draw the plow are self-anchoring and have 14-in. vertical drums, each drum holding 1,000 ft. of cable.

Four heavy horses are used on each capstan, working abreast and pulling at the end of a sweep that is attached direct to the drum. This sweep is usually about 24 ft. long, and the horses describe a circle nearly 50 ft. in diameter in order to wind in 3 or 4 ft. of cable. The work is so severe that relays of horses are used, and there are usually about 20 horses with each ditching rig.

These horse-driven ditching plows cut about 100 rods of ditch per day. In Wisconsin they frequently cut 50 mi. of ditch in one season at a contract price of from $1.25 to $2 per rod of ditch, depending upon the character of the soil. Ditches made in stony or timbered lands are the more expensive. Fig. 1 shows the plow and capstan of the horse-driven outfits.

Power-Operated Capstan Plows

Since the gasoline engine has entered the field as a source of power, several attempts have been made to develop a power capstan that would replace the horse and further be able to operate on soft, boggy ground where it is impossible to work with horses. Such a machine has been developed by the Glencoe Ditching Co., of Glencoe, Minn. Engineers and mechanics were engaged to design and build a machine on the lines suggested by men of long experience in the use of plow ditchers. For information we are indebted to J. J. Hankenson, of the company. The final form taken by this power capstan after repeated trials and rebuilding is shown in Fig. 2.

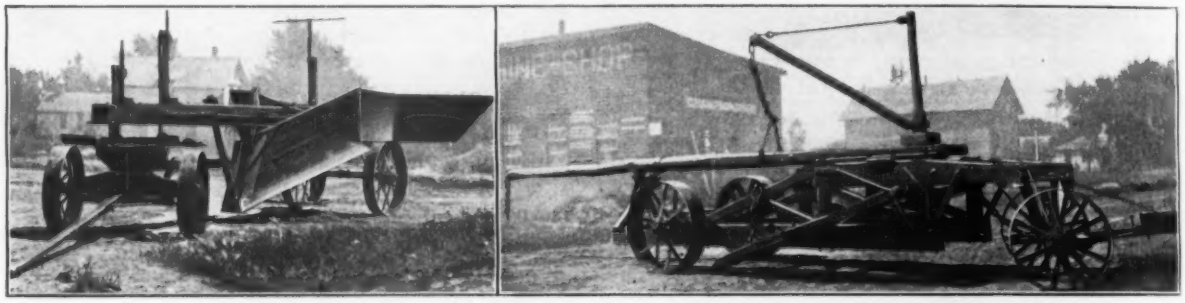


FIG. 1. PLOW AND CAPSTAN FOR DITCHING BY HORSE TRACTION

At the left is the plow (in raised position), with side wing to form a berm along the top of the ditch. At the right is the capstan. The long horizontal pole is the sweep by which the horses turn the drum, and the inclined timbers (one on each side) are the anchors which hold the capstan wagon in position while the drum hauls in the plow cable

A gasoline tractor supported by two long caterpillars 30 in. wide carries a cable drum. Two anchor flukes, 2x10 ft., are placed near the front of the machine, one on each side. They are held at the proper angle by heavy chains attached to the frame of the tractor. These anchors hold the power capstan stationary when the plow is being pulled forward to cut the ditch.

The 1⅜-in. steel pulling cable is wound upon a large built-up cast-steel drum attached to the rear of the machine. This drum is 24 in. long, 16 in. in diameter, with flanges 36 in. in diameter. It is driven by two heavy link-belt chains from the main driving shaft of the tractor and is so back-geared that when the 60-hp. motor is running at its normal speed the drum winds in the pulling cable at a rate of 14 to 18 ft. per min., depending upon the amount of cable on the drum. The drum holds about 1,000 ft. of cable. When greater length is required, on account of inaccessible grounds, etc., removable sections of 500 or 600 ft. of cable are used to attain the desired length.

The tractor with power capstan has proved so successful that others are now being built to be put in the

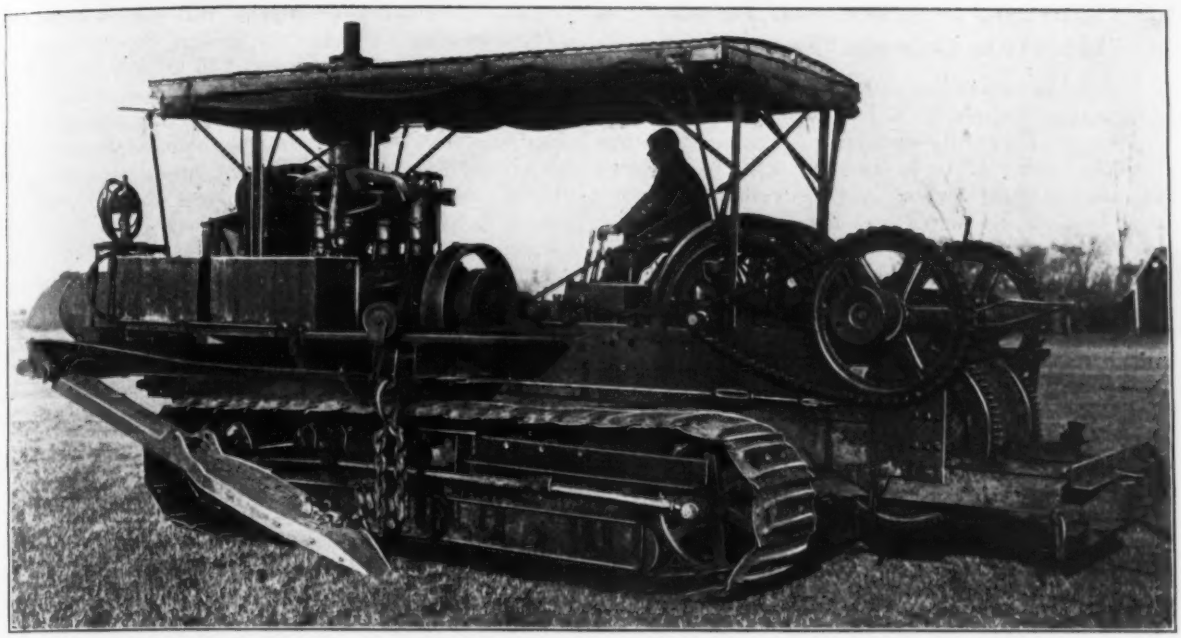


FIG. 2. CATERPILLAR TRACTOR WITH DRUM FOR HAULING THE DITCHING PLOW

When plowing, the tractor is stationary and is anchored by the inclined spuds while the 60-hp. engine drives the drum for winding in the plow cable

contracting field next summer. It has been found that the pulling power is so much greater than that of the horse machines that the size of the plow can be increased. The new plows will cut ditches 2 ft. wide on the bottom and 3½ ft. deep. They are made for the ditching company by the Glencoe Foundry and Machine Co., of Glencoe, Minn.

Operating the Power Ditching Plow

The power capstan retains its original feature as a tractor and is used to haul the plow (which weighs 4 tons when mounted on its removable trucks), a wagon loaded with cable and supplies, and a boarding cabin mounted on wheels. It takes this outfit over ordinary country roads at the rate of about 2 mi. per hr. The machine weighs about 15 tons; but owing to its large bearing surface, it can travel under its own power over swamp lands too soft to support a team. It is driven by a four-cylinder four-cycle gasoline engine of 60 hp., which also furnishes power to drive the winding drum.

In operation the plow is left at the starting point of the ditch, the cable being attached to the beam of the plow. Then the power capstan moves ahead to some point on the line of the ditch to be cut, paying out the cable as it advances. When this point is reached, the traction gear is released and the winding apparatus to the drum is thrown into gear. The anchors are released, allowing the points to drop on the ground. As the cable to the plow becomes taut, it draws the machine backward, causing the anchor flukes to enter the ground until the tractor with its capstan becomes firmly anchored.

When all the cable is wound on the drum, or a change in the direction of the ditch is to be made, the winding gear is thrown out of action and the traction gear is thrown in. As the tractor then advances, it pays out the cable and withdraws the anchors, which are hooked up clear of the ground by power, and the machine proceeds to a new point of setting, as determined by the foreman. Fig. 3 shows a ditch cut by one of these machines.

The power capstan is operated by one man and a helper; one man rides on the plow, and a team with driver is used in hauling supplies to the camp and to the machine. A cook in the portable cabin on wheels furnishes the food for the crew. A foreman directs the movements of the whole outfit.

FIG. 3. DRAINAGE DITCH EXCAVATED AT ONE CUT BY THE POWER-DRIVEN CAPSTAN PLOW

The Electric Towing Locomotive to handle the vessels through the Panama Canal locks were originally designed to run at a maximum speed of 2 mi. per hr. Experience has developed that in handling very heavy vessels this speed is excessive, and investigations have been made to determine some feasible method of decreasing the speed of towing. According to the "Canal Record" of Jan. 5, it has been found feasible so to alter the electrical connections of the two main traction motors of each locomotive that their speed is halved and the vessel is propelled at 1 mi. per hr. The induction motors used on the locomotive always tend to reach synchronous speed, and by connecting the two motors in cascade they operate at about one-half the speed for which the machines were designed. With the motors connected in cascade it is possible to get approximately a 30,000-lb. tractive effort on the tow line. Excessive stress on the tow line is guarded against, however, by the slip connections on the cable drums, which are adjusted to slip when the pull on the tow line reaches 25,000 lb.

Subaqueous Excavation at the Halifax Ocean Terminals

A most important part of the work on the new Ocean Terminals at Halifax, N. S. (see *Engineering News*, Dec. 9, 1915, p. 1118) is the excavation of the harbor bottom, not only to provide the 30- to 45-ft. depth in the berths and alongside the landing quay, but also to insure a solid base on which to found the concrete blocks that are built up in tiers to form the quay and pier walls.

Halifax harbor is very deep, so that little dredging is required to provide the required 45 ft. in the channel; but the new terminals are being built out from the shore, where the present minimum depth is only about 10 ft., so that excavation has to be made in the rock bottom from the bulkhead line out to a short distance beyond the pier-head line. This rock is overlain with very little mud, so that all excavation is made by the customary drilling, shooting and bucket methods. In some places, however, the rock, while well below the required depth, is so stratified and laminated as to make it an insecure base for the concrete pier walls, and in these locations excavation to solid rock has to be carried as low as 70 ft., rubble mounds being afterward placed as bases for the concrete blocks.

Description of Drill Boats

The total subaqueous excavation will be about 250,000 cu.yd. For the work, two drill boats have been in operation for about a year, the excavation being done by various dredges loading into bottom-dump barges that deposit the spoil behind the quay and pier-wall lines to form the fill on which the terminal buildings and tracks will stand.

The drill boats are similar in design and equipment, except that one has ten Keystone well-drills and the other seven. Each is self-contained as to power. The view in Fig. 1 shows the seven-gang drill boat in operation. These boats work ahead of the dredges, drilling to depths of about 50 ft. below low water (56 to 60 ft. below high water)—that is, about 5 ft. below excavation grade. About 80 ft. of holes is drilled, and then the boat is pulled back to permit the loading of the holes preliminary to shooting.

A novel method of loading and shooting was designed for this work by C. D. McArthur, now Chief Engineer of the Blaw Steel Construction Co., when he was Chief Engineer for the contractors on the Halifax work. Mr. McArthur worked out this scheme after several unsuccessful attempts to use the ordinary methods for loading and shooting such holes.

The sketch in Fig. 3 shows on the right the detail of the charging casing and buoy, and on the left a rough perspective of the method of connecting the buoys with the battery.

After the depths of the holes have been determined, the charges are made up in the powder house, with the exploders in place and the buoys attached to the exploder wires. In this case the exploder wires are 60 ft. long. In order to prevent water from leaking into the electric connection at the top of the buoy, which is in the buoy casing, a blank cap is placed over this casing and held in place by the thumb-nuts. This blank cap is not shown in the drawing. All of this preparation is done by the powderman in the powder house, and the charges are taken out to the drill scow in a rowboat.

After the drilling is finished and before the casing pipes are removed, the charge is dropped into each hole, together with the buoy. In lowering this charge into the hole a rope is slipped through the tie wire at the top of the charge casing. After being lowered down to the bottom of the hole, this rope is slipped out and the buoy dropped into the drill casing afterward. After all the holes are loaded, the drill-casing pipes are pulled. The buoys then float on the surface of the water. Two men

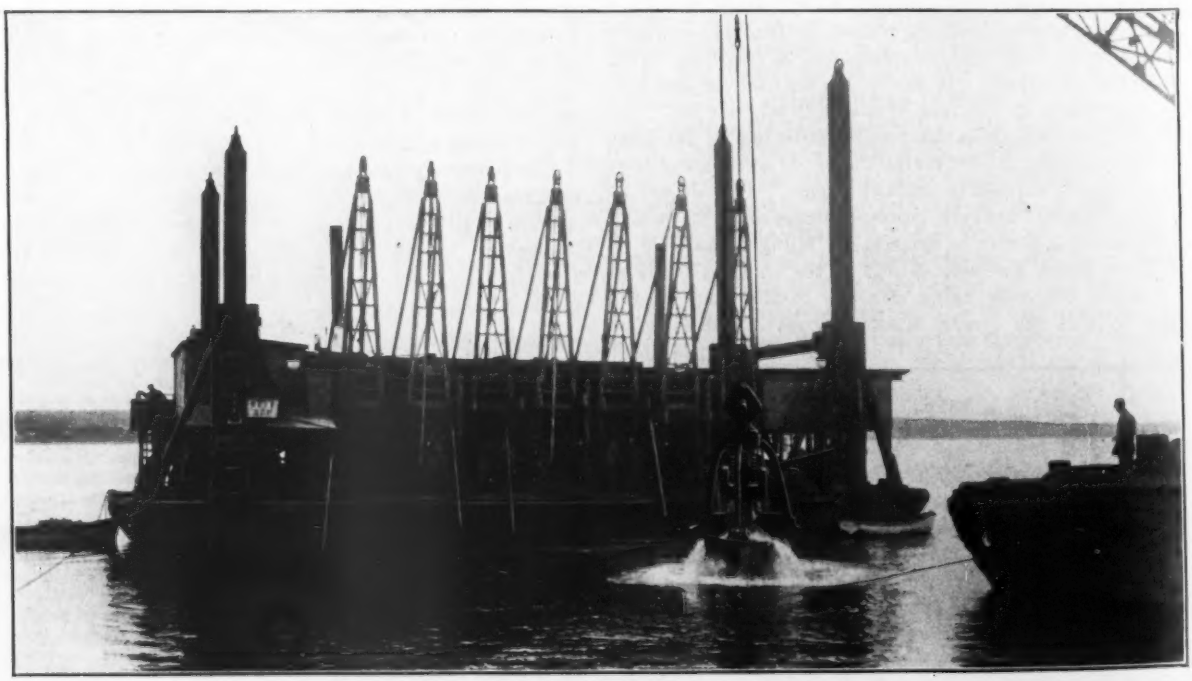


FIG. 1. SEVEN-GANG DRILL BOAT AT WORK IN HALIFAX HARBOR

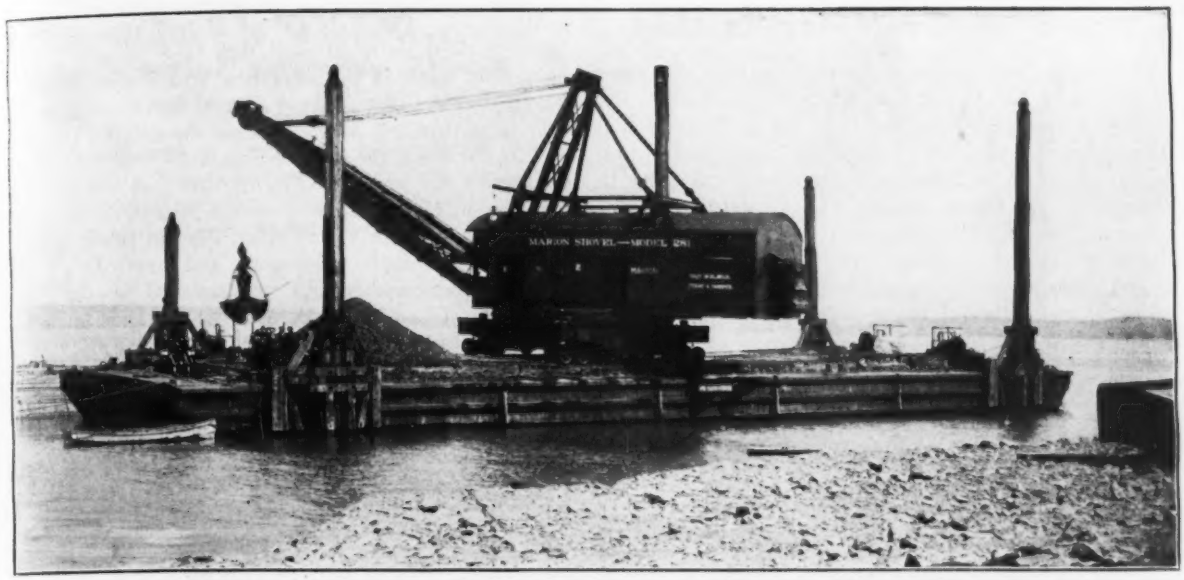


FIG. 2. LARGE MARION DRAGLINE SCRAPER RIGGED AS DREDGE

in a rowboat take the main cable, to which are attached the main-cable caps, and remove the safety cover from the top of the buoy, replacing it with the cap that is on the main cable. Thus, as shown on the drawing, positive electric connection is made between the main cable and the exploder wires.

Just before making this connection, each one of the charges is tested with a galvanometer, to see that the electric connection is right; and after all the buoys have been connected up to the main cable, a similar galvanometer test is made just before the main-cable wires are attached to the battery.

While the men are making these connections from a rowboat, the drill scow is being pulled back from over the holes to a distance of 75 to 100 ft. By the time that the scow is away far enough, the men are ready to shoot the holes. This time rarely exceeds 10 min. The actual time in connecting each buoy is but a minute or so.

It has been found that from 1½ to 2 lb. of 75% dynamite is required per cubic yard of excavation.

Dredges and Orange-Peel Excavators

Following behind the blasting, the excavation is made normally with the Canadian Government's 12-yd. dipper dredge "Cynthia." For a time the Government dredge "King Edward" was also working, but that has now been sent to another station. For the deepwater dredging—up to 70 ft.—the large machine shown in Fig. 2 is being used. This is a Marion dragline scraper crane of the heaviest type—model 281—which was bought mainly for the block-setting work. It has been mounted on a barge especially braced to hold it and, with a large orange-peel has proved very useful in the deepwater dredging.

This machine has a rated capacity of 75 tons and a boom length of 65 ft. It is mounted on five 4-wheel trucks, disposed on the corners and center of a rectangle. As shown in Fig. 2, the tracks on the barge are raised at the ends to prevent the crane from running overboard. Another Marion dragline scraper—model 261—similarly equipped with a 5-yd. bucket, is provided for the subaqueous work, but so far has been used largely for sand and gravel unloading.

The harbor contract for the Halifax ocean terminals is held by Foley Bros., Welch, Stewart & Fauquier. C. D. McArthur was Chief Engineer for this firm during the first year and a half of the contract and had charge of the plant layout. J. W. Roland is now Chief Engineer,

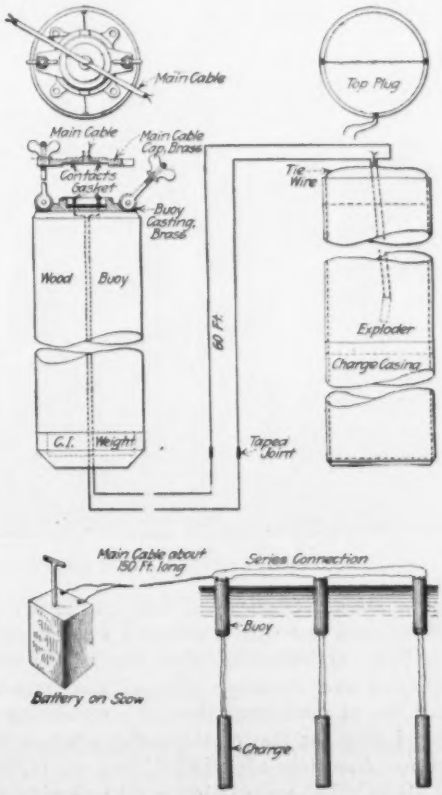


FIG. 3. METHOD OF LOADING AND FIRING CHARGES AT HALIFAX

and J. P. Porter and R. B. Porter are in charge of the work. James McGregor is Superintending Engineer, in charge of design and construction for the Canadian Government, which is building the terminals.

Rapid Water-Meter Testing

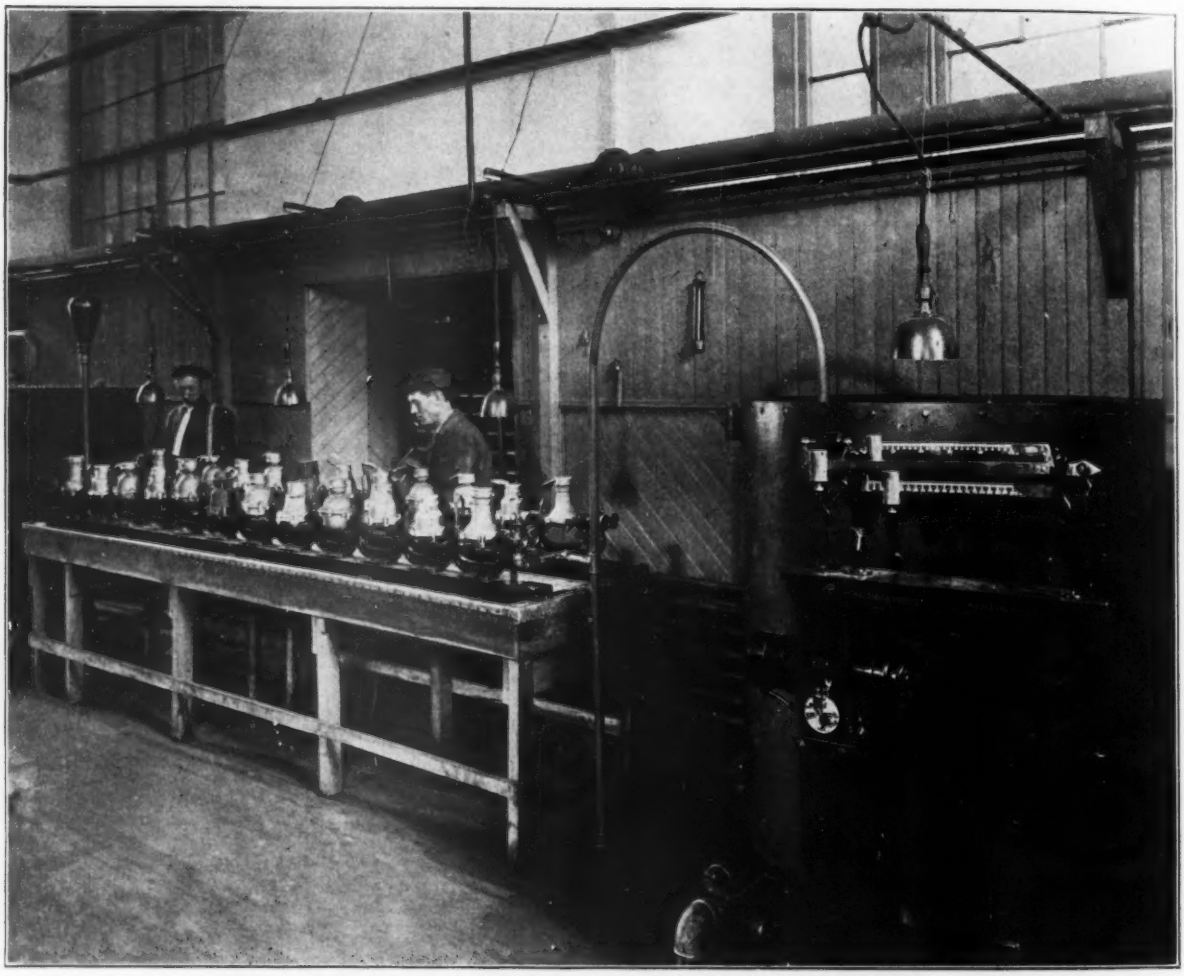
Apparatus that makes it possible to have 34 water meters under test at one time while 24 others are being set up in preparation for test is in use at Philadelphia. The equipment consists of five testing frames mounted on tables. Four of the frames contain yokes for holding 12 meters, and one frame contains a yoke for 10 additional meters. One of the tables with its weighing tank is shown in the accompanying view.

The yokes are made of cast iron and are bolted to a 4-in. channel. Each table contains two frames spaced about 19 in. apart. Connections between the two frames are made at each end with a common water-supply and discharge line. Quick-acting valves control the water on both the inlet and discharge sides of the frames. On the outlet side of the frames there is a regulating orifice so arranged that the size of the outlet streams may be adjusted for diameters of 1 in., ¾ in., ⅝ in. and on down to ½ in. Pet-cocks on each yoke provide for the escape of air from the supply line. Any loose play between the meters and the yokes is taken up by means of wedges driven in between rings at the ends of each yoke.

In making a test, meters are first set up on the frames and the type and the number of each meter recorded. Water is allowed to run through the meters until all air is displaced. The dials are set at zero and water run through them until 10 cu.ft. has been recorded. The amount of water in the measuring tank is then weighed. The meters are passed if the amount registered does not vary more than 2% above or below the weighed amount.

With the use of the three testing tables from 290 to 310 meters per day were tested during the past season. The rush period for testing new meters is confined to about three months of the year. When the test tables are not required, they can be taken down and removed.

The apparatus described was supplied by the Ford Meter Box Co., of Wabash, Ind. John Latimer is superintendent of meters, and C. E. Davis is chief of the Bureau of Water of Philadelphia.



FORD WATER-METER TESTING APPARATUS IN USE AT PHILADELPHIA, PENN.

⁂

Projected Road Improvements in Essex County, New Jersey, for construction within the next year or two, show a total estimated cost of $628,000, part of which will be contributed by the state. A variety of surfacing material has been chosen to meet different local conditions. The material chosen includes waterbound macadam, bituminous concrete, amiesite, granite cubes (on a hill slope) and granite blocks. Work already under contract includes, besides the sort of material named, bitulithic, asphalt block and warrenite. A road-traffic census was taken during the past season and will be continued during the coming season, under the direction of F. A. Reimer, County Engineer, County Court House, Newark, N. J. Mr. Reimer recommends that during the coming season asphaltic instead of nonasphaltic oil be used for surface treatment of roads to prevent dust.

Turnouts for Narrow-Gage Industrial Railway Track

By Ralph D. Brown*

The development of narrow-gage railway track is confined chiefly to limited layouts for industrial plants and to mining operations where limited clearances necessitate its use. A coal-mining company operating many mines

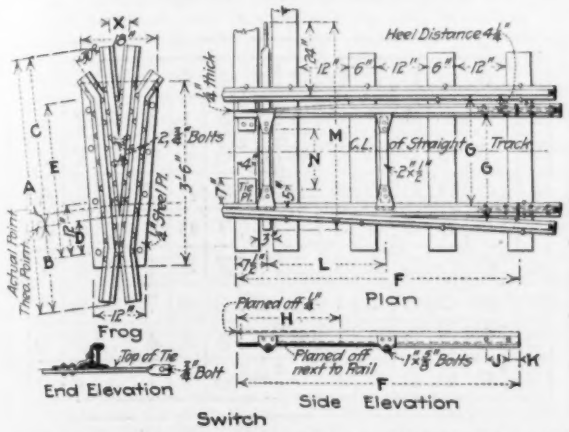


FIG. 1. STANDARD FROG AND SWITCH DESIGN FOR NARROW-GAGE MINE AND INDUSTRIAL TRACKS

which had been developed independently was forced by economic necessity to standardize its equipment. As some of the mines were already developed extensively, it was not considered advisable to relay the tracks entirely to change the gage, but it was found possible to use one type of frog and switch for all turnouts.

Standard designs were adopted, and the results of computations were placed in tabular form for the use of the construction gang. Certain assumptions had to be

TABLE 1. DIMENSIONS OF STANDARD FROGS AND SWITCHES FOR NARROW-GAGE INDUSTRIAL AND MINE TRACKS

Standard Frog for Motor Turnout (Right or Left)

Frog No.	Frog Angle, X Deg.	Min.	Wt. of Rail, Lb. per Yd.	Length of Frog, A Ft.	In.	Length of Wing Rail, B In.	Heel Distance, C Ft.	In.	Length of Throat, D In.	Length of Straight Rail, E Ft.	In.
3	18	55	30	4	0	16	2	8	3⅛	2	3
4	14	15	30	4	8	20	3	0	5¼	2	9
4	14	15	40	4	8	20	3	0	6¼	3	0
5	11	25	30	4	10	20	3	2	7⅛	3	0
5	11	25	40	5	0	20	3	4	8¼	3	0

Standard Switch*

Wt. of Rail, Lb. per Yd.	Length of Point, F Ft.	In.	Dist. Between Bridle Rods, L Ft.	In.	Length of Rail Planed, H Ft.	In.	Rail Punching J In.	Rail Punching K In.	Gage of Track, G In.	Length of Bridle Rod M Ft.	In.	Rod Punching, N In.
20	4	0	(1 rod)		1	4	4	2	36	5	8¼	25
25	4	0	(1 rod)		1	6	4	2	40	6	0¼	29
30	4	0	(1 rod)		1	9	4	2	42	6	2¼	31
30	6	0	2	3	2	6	4	2	44	6	4¼	33
30	7	6	3	0	3	0	4	2	48	6	8¼	37
40	6	0	2	3	2	9	5	2¼	—	—	—	—
40	7	6	3	0	3	6	5	2¼	—	—	—	—

*The throw of switch point is 3½-in. for all cases.

made, such as the length of the wing rails of the frog and the heel distance of the switch, but they were all within the limits of accepted practice and can be applied to any industrial-track system. The designs of the frog and switch point, shown in Fig. 1, were made after considering both simplicity and economy of construction. Any ordinary blacksmith or ironworker will make these parts without difficulty. The cost of making a No. 5 frog and two 6-ft. switch points at a well-equipped mine shop was as follows: Material, $6.37; labor of blacksmith and machinist, $6.58; total, $12.95.

A cast-steel frog supplied by manufacturers at a cost of about $6.50 is inherently more rigid than the riveted frog, but unless unusual precaution is taken it is difficult to fasten it securely to the ties. In order to stiffen the riveted structure, cast-iron fillers may be added which also support the flange of the wheels in passing over the throat of the frog, thus relieving the jar to the rolling stock.

In designing various parts of the turnouts it was kept in mind that all such turnouts may be of only temporary usefulness in one particular location and that the constituent parts may be used many times before being cast aside as useless. The standard frog is somewhat shorter than one designed to the specifications of the American Railway Engineering Association, but the saving in weight and bulk with the consequent saving in making the several installations will more than offset any loss due to instability.

The cost of laying and ballasting a No. 5 turnout complete, as shown in Fig. 2, was as follows:

One 30-lb. No. 5 frog and two 6-ft. points	$12.95
40 ties, 5x6-in., @ 20c.	8.00
Spikes, bolts, tie-plates, etc.	.75
1 low switch stand and rods	2.25
2 headblocks, 5x6-in., 8 ft. long	1.00
Total material	$24.95
Laying, 16 hr. @ 35¼ c.	5.68
Ballasting and surfacing, 8 hr. @ 35½ c.	2.84
Total labor	$8.52
Total cost of material and labor	$33.47

The dimensions of the standard frogs, switches and turnouts are given in Tables 1 and 2. The formulas used for the turnouts are as follows:

$$\text{Chord length } U = \frac{G - B \sin X - F \sin Y}{\sin \frac{1}{2}(X + Y)}$$

$$\text{Radius } R = \frac{G - B \sin X - F \sin Y}{\cos Y - \cos X} - \tfrac{1}{2} G$$

$$\text{Lead } S = (R + \tfrac{1}{2} G)\ (\sin X - \sin Y) + B \cos X + F + O$$

in which

X = Frog angle;
Y = Angle of point rail;
B = Length of wing rail;
F = Length of switch rail;
O = Distance between actual and theoretical frog point, taken as 2 in.;
G = Gage of track;
R = Radius of turnout.

The dimensions of O was taken as 2 in. and the heel distance of switch points as 4¼ in.

The spacing of the ties depends on the size of the tie and the style of the turnouts. If the regular set of switch ties is used as in standard-gage trackwork, 5x6-in.

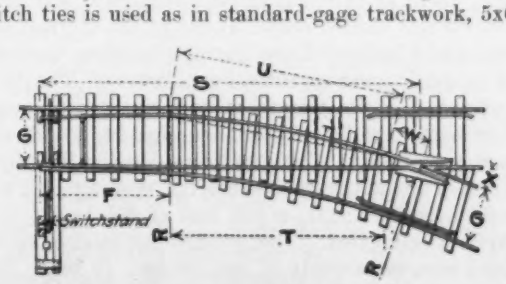


FIG. 2. STANDARD TURNOUT FOR NARROW-GAGE MINE AND INDUSTRIAL TRACKS

*Assistant General Superintendent, O'Gara Coal Co., Harrisburg, Ill.

ties spaced 18 in. c. to c. will give good results for track laid with rails weighing up to 40 lb. per yd. If the turnout is laid with ties of even length staggered in, as shown in Fig. 2, a spacing of 16 to 18 in. c. to c. for each branch has proved satisfactory. This style of construction is specially well adapted to underground turnouts, where headroom is limited and flat ties 3x5 in. or 3x6 in. are used. All switch ties should be of hardwood and treated if possible, as decay will set in before mechanical wear destroys their usefulness.

TABLE 2. DIMENSIONS FOR TURNOUTS IN NARROW-GAGE TRACKS*

Frog No.	Length of Switch Points, F	Radius of Turnout, R	Length of Lead, S	Length of Straight Rail, T	Chord of Curved Rail, U	Middle Ordinate of Curved Rail, V
	Ft.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	In.
Gage of Track, 36 in.						
3	4	42 7 1/16	16 3 11/16	10 9 11/16	10 10 5/16	4 1/16
4	4	81 1 1/2	19 3	13 5	13 8	3 1/4
4	6	75 8 1/2	22 6	14 8	14 10 1/4	4 1/16
5	4	141 7 1/2	22 2 1/4	16 4 1/4	16 7 1/16	2 1/4
5	6	126 7	26 0 1/4	18 2 1/4	18 4 1/4	3 1/16
5	7 1/2	122 9 1/4	28 4 1/4	19 0 1/4	19 2 1/4	4 1/16
6	7 1/2	184 9 1/4	30 9 1/4	21 5 1/4	22 9	4 1/16
Gage of Track, 42 in.						
3	4	52 1 11/16	18 0 1/4	12 11 1/4	13 3 1/4	4 11/16
4	4	99 2 1/4	22 3	16 5	16 8 1/4	4 1/4
4	6	92 6 1/4	25 9	17 11	18 2 1/4	5 1/4
5	4	172 0 1/2	25 9 1/4	19 11 1/4	20 2	3 1/4
5	6	153 8 1/2	29 11 1/4	22 11 1/4	22 3 1/4	4 11/16
5	7 1/2	149 1 1/2	32 5 1/4	23 11 1/4	23 4	5 1/16
6	7 1/2	223 5 1/4	36 7 1/4	27 3 1/4	27 6	5 1/16

*The table prepared by Mr. Brown includes five widths of track gage—36-in.; 40-in.; 42-in.; 44-in.; and 48-in. We give the figures for the 36-in. and 42-in. gages only.—Editor.

Too often the trackwork for mines and industrial works is poorly executed, due to lack of experience of the tracklayers and construction foremen. The essential requirements do not differ from those of the standard gage, and true alignment and surface may be obtained by intelligent supervision.

Load Tests of Foundation Soil in the Philippines

In building a bridge at Mainit, Leyte Province, Philippines, a foundation load test was made in the excavation for the main pier, to determine whether the soil was capable of bearing the design load of 3.75 tons per sq.ft. The Bureau of Public Works describes the methods and results in its "Quarterly Bulletin." The loading platform, about 10 ft. square, rested on four 6x6-in. legs and thus had a total bearing area of 1 sq.ft. It appears to have been simply set on the bottom of the foundation pit and leveled up, the feet not set in holes or any backfill placed around them. The platform was first loaded with 1,300 lb. of structural steel; after an hour the settlements at the four corners were 1, 7, 12 and 14 mm. Then a load of 7.6 tons was applied. The additional settlement was greatest at the two corners that had settled least before, being 74 and 75 mm. (3 in.); at the other two corners it was zero. Excavation was carried deeper at the points of great settlement, and a better soil was found, whereupon this part of the excavation was considered satisfactory. The other half of the pier site was more uniform in settlement, the four corners of the platform showing 21, 22, 29 and 22 mm. respectively, which was considered satisfactory.

In one of the abutments, where the working load was to be 3.05 tons per sq.ft., a test load of 6½ to 6¾ tons per sq.ft. was applied. The average settlements under this load were respectively 35 and 50 mm. (2 in.). The result was considered satisfactory, and foundation concreting was at once begun.

NOTES

Acre Conversion Table—A highly simplified table for converting square feet into decimals of an acre has been worked out by Dwight Gerber, Chief Engineer of the Pittsburgh Terminal Railroad and Coal Co., as shown herewith. In the table the figures at the right of those in the first or left vertical line are the decimal acre equivalents for tenths of a square foot. For instance, the figures at the right of the 1 on the first horizontal line are the decimal acre equivalents of 0.1 sq.ft. Having on the third line, for example, the decimal value of 0.3 sq.ft., it is evident that this value can also be used for 0.03, 0.003, 3, 30, 300, 3,000, etc., sqft., by properly placing the decimal point. Attention is called to the words printed vertically between the columns of figures, as these words are intended to serve as guides in the placing of the decimal point. To illustrate: The acre equivalent of 300 sq.ft. is obtained by placing the point at the word "hundreds." Anyone who will follow the operations in the example given below will readily grasp the working of the chart. For instance, what part of an acre is 576.4 sq.ft.?

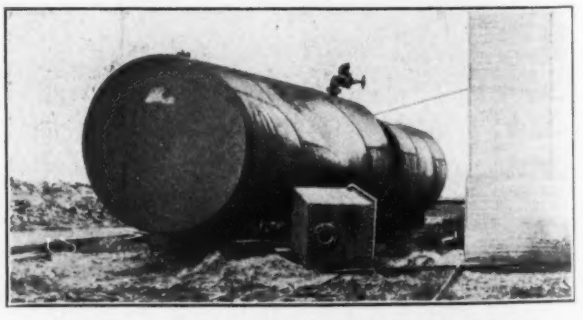
1	.	0	0	0	0	0	2	2	9	5	6	8	4	1
2	.	0	0	0	0	0	4	5	9	1	3	6	8	2
3	.	0	0	0	0	0	6	8	8	7	0	5	2	3
4	.	0	0	0	0	0	9	1	8	2	7	3	6	4
5	.	0	0	0	0	1	1	4	7	8	4	2	0	6
6	.	0	0	0	0	1	3	7	7	4	1	0	4	7
7	.	0	0	0	0	1	6	0	6	9	7	8	8	8
8	.	0	0	0	0	1	8	3	6	5	4	7	2	9
9	.	0	0	0	0	2	0	6	6	1	1	5	7	0

TABLE FOR RAPIDLY CONVERTING SQUARE FEET INTO DECIMALS OF AN ACRE

$$
\begin{aligned}
500.0 &= 0.0114784206 \\
70.0 &= 0.00160697888 \\
6.0 &= 0.000137741047 \\
0.4 &= 0.0000091827364 \\
\hline
576.4 &= 0.0132323232634
\end{aligned}
$$

This operation may be shortened to a considerable extent by sacrificing extreme accuracy.

Concussion Collapsed Tank—The accompanying view shows the gasoline-storage tank in the garbage-disposal plant of the C. O. Bartlett & Snow Co. at the Panama-Pacific Exposition, San Francisco. C. O. Bartlett, president of the company, says that the tank was deformed, as shown, by the concussion of the big coast-defense guns at Fort Winfield Scott during target practice on Nov. 3, 1915. The tank was 6 ft. 9 in. in diameter by 22 ft. long and made of ⅜-in. iron. As shown in the photographs, it was sustained by wood-frame supports about 4 ft. from each end. The concussion of the guns, which were located about 400 yd. from the garbage-plant side, had the effect of caving in the middle of the side of the tank nearest the buildings. The top of the tank was forced up, giving it a humpbacked appearance. At the time it gave way the tank contained 4,000 gal. of gasoline.



GASOLINE TANK COLLAPSED BY CONCUSSION

Editorials

Rival Materials for Water Conduits at Seattle

In these days of intense rivalry between those who are commercially interested in different materials of construction it is to be expected that any mishap to a structure of one material will be exploited in behalf of the other materials which might have been used in place of that which has met with accident. No one can blame commercial rivals for this sort of thing, but the representatives of those who have to foot the bills may be expected to try to arrive at the truth. The chances are that they will not so arrive unless they employ competent engineers to guide them. Too often they fail to do this, and therein lies the opportunity of the man whose chief and wholly commendable concern is to sell his own product.

The break in one of the wood-stave conduits which conveys Cedar River water to Seattle, noted in *Engineering News* of Jan. 20 and 27, is a case in point. As soon as it was generally known that several breaks had occurred in one of these two pipe lines, some of the local newspapers and laymen city officials began to cry out for a "permanent" conduit of "steel and concrete." This outcry arose notwithstanding the fact that the wood-stave conduit in which the breaks occurred was put in use as recently as 1909, and the second and older wood conduit no longer ago than 1901. Moreover, as was pointed out in these columns on Jan. 27, the agitation centered on a third conduit, although the underwriters and the technical staff of the city had for years past been advocating more storage and a special fire-protection water-supply system.

Perhaps a third conduit is more needed than anything else, and perhaps it should be built of "concrete and steel." Both questions should be settled by engineers. In fact, this time it would really seem as though the taxpayers of Seattle would be weary of lay muddling with engineering questions and once more put their trust in engineering advisers.

The report printed elsewhere in this issue places the blame for the recent breaks in the Seattle conduit on faulty design and maintenance of relief standpipes at summits and urges that the same poor design and maintenance of a steel or of a concrete pipe line would have been just as likely to have resulted in an accident, with the probability of longer delay for repairs than was necessary with the wood conduit. The report is admittedly a defense of wood-stave pipe against possible enemies, but it is made in behalf of the wood-pipe interests in general rather than a prospective contract at Seattle. So considered it is entitled to respectful consideration—exactly as are all arguments against wood pipe brought forward in good faith by the promoters of steel, concrete or cast iron.

The taxpayers and the lay officials of Seattle and of other cities confronted with questions like those at issue in this case should listen respectfully to the claims of commercial rivals; but in weighing those claims they will do well to be guided in the end by competent disinterested engineers whose sole interest is not to promote the use of any one material against all others, but to recommend that one which will best meet local conditions and in the long run render the best service at the least cost.

Reporter for City Manager

The very latest thing in municipal government is the combination of proportional representation with the commission-manager plan. The argument for the commission-manager plan is well known and has much force. Proportional representation is an apparently well-devised scheme for making sure that all the diverse elements composing the electorate are present in the city government, in so far as that is possible without attempting to recognize too small divisions of the electorate.

The only American city that has thus far adopted proportional representation is Ashtabula, Ohio. In 1914 that city adopted a home-rule charter of the commission-manager type. Proportional representation was advocated at the time, but not with sufficient strength to assure its adoption. In August, 1915, the charter was amended to include this principle. In November the first commission was elected in accordance with the proportional-representation scheme. Seven men were chosen. The enthusiastic supporters of proportional representation, including the Chamber of Commerce of Ashtabula, reported that the election was a success, both in practical operation and as to results. It was stated that every section of the city was represented geographically, that all parties had their representatives, including even the wet and the dry, and that the leading nationalities in the decidedly polyglot city were also well represented on the new commission.

Under a commission-manager charter, whether the commissioners are elected by proportional representation or otherwise, the supreme test of the new administration is naturally that of the appointment it makes to the very important office of city manager. Ashtabula, a city of 18,266 population in 1910, offered $2,500 for a city manager. The applicants included a number of nonresidents, some of whom are or have been city managers elsewhere. The commission finally selected a local newspaper reporter for the position.

This choice proves anew, not that proportional representation is a failure, but that no mere framework of government will insure the choice of trained men for executive positions. It may be that a local newspaper reporter will eventually make an excellent city manager, or at least just the sort of a city manager the people of Ashtabula desire. If either proves to be the case, will not proportional representation be justified at its very first trial in the United States?

Automobiles and Safety in the Streets

Is the deadliness of the automobile to pedestrians increasing or decreasing? Statistics for 1909 to 1914, just made public by the Bureau of the Census, Department of Commerce, indicate that the number of automobiles in the United States increases more than twice as rapidly as the number of fatalities caused by them. This showing means that while an increased number of motor vehicles increases the accident record, the hazard per automobile operated is growing less.

Automobiles in use in the United States at the close of 1909 numbered 200,000, according to figures compiled by the National Automobile Chamber of Commerce by New York City, from state registration reports; at the close of 1913 there were 1,270,000, and at the end of 1914 the figure was 1,750,000. Meanwhile the deaths caused by automobile accidents and injuries for both pedestrians and passengers, increased from 632 in 1909 in the death-registration area, containing 56% of the population of the United States, to 2,623 in 1914. Thus while the number of automobiles increased 775% in this period of five years, the fatalities increased but 315%. These figures can be verified to some extent by a comparison between the increase in the number of machines and the increase in the death rate per 100,000 population, caused by them. On this basis the 775% automobile increase was accompanied by a fatality increase of 258%, or from 1.2 to 4.3 per 100,000.

In spite of the proportional decrease, these figures are ominous, for they emphasize the generally known fact that the streets are becoming less safe each year. Automobile travel is bound to expand, and probably as rapidly in the next five years as heretofore. This outlook calls for careful regulation of automobile travel so that the fatalities will continue to diminish in proportion to the increase in the number of vehicles. One reason for the inverse ratio is a reduction in the average annual mileage per machine. It is hoped that another reason lies in a greater regard for public safety by the drivers.

⁂

Do Faulty Estimates of Cost Mislead Contractors?

That the engineer's estimate should be approximately accurate and include a margin of profit for the contractor is important from the standpoint of the contractors bidding; that the estimate is not always a safe guide is generally known to the contracting fraternity. A correspondent in this issue throws some interesting light upon a contract on which he recently submitted a bid. His estimate, which he offers, seems to be fair, and he complains that the only item that could stand trimming, without departing from the specifications, is the one known as profit. Yet his bid was $40,000 higher than the engineer's estimate. This would not be a grave difference in the case of a $1,000,000 contract, but on a job which the engineer estimates at $70,000 a $40,000 difference is striking, to say the least.

If contractors would prepare their bids without regard to anyone else's process of thought, the engineer's estimate would be of less consequence. A new and inexperienced contractor, however, assumes that the engineer knew what he was doing when he prepared his estimate. So the contractor shaves the estimate and finds that although the engineer may have known what he was doing, he (the contractor) was in abysmal ignorance on that point. The new contractor feels that in order to succeed he must gain a reputation, which calls for sacrifice. Therefore, he is willing to take a job or two at or below cost in order to get a start. He gets his start, but as often as not it is in the direction of the well-populated graveyard of his profession.

The engineer who makes an absurdly low estimate for the cost of a proposed work is even more censurable than the one who makes his estimate absurdly high in order to help his own reputation for performing work below its estimated cost. In nine cases out of ten, however, the engineer who makes an estimate below cost and deceives some contractor into making a bid based on that estimate will receive a punishment fitting his crime.

⁂

Inward-Opening Doors Again

The excessive accident record of American industries is often referred to with the implication that in European industrial establishments the safety arrangements are perfect. This does not appear to be the case, judging from a recent item telling of the death of 18 persons in a Swiss factory fire, where they were caught at an inward-opening door. An editorial remark on this case in the *Schweizerische Bauzeitung* implies that this condition is not uncommon and that the Swiss factory inspectors find much difficulty in securing compliance with their recommendations as to safety appliances.

In the case in question the ground floor had three doors. When a fire broke out, the employees crowded to the door that was most commonly used. This door, however, had been blown shut by an explosion which started the fire, and with such force that it swung through its frame and jammed.

The danger of inward-opening doors in any building housing large numbers of people has been many times demonstrated, and it is a surprise to find that such dangers have not yet been generally eliminated even in the well-regulated factories of Europe.

⁂

Is Chuting Concrete Dangerous?

In spite of the almost universal acceptance of the chute as a method of depositing concrete there remain a number of engineers who hold to the early opposition to the method, on the ground that its very nature demands an exceptionally sloppy concrete that will not attain as high an early strength—to say nothing of final integrity—as a concrete mixed with a normal, and lower, proportion of water.

Such criticism is possibly deserved, but it lacks qualitative backing, either in the way of structural performance or laboratory experiment. For that reason, those interested in the subject, whether they are for or against the chute, should make an effort to attend the coming meeting at Chicago (Feb. 14 to 17) of the American Concrete Institute and take part in the discussion of the subject which is to be started by C. C. Brown, of Indianapolis. Mr. Brown has been collecting data on the subject for some time, and his notes, together with the comment, either spoken or written, presented at the meeting, should add much to the present meager information on a debatable subject.

Letters to the Editor

Septic-Tank Patent Claims and Sewage-Disinfection Tanks

Sir—On several recent occasions there have come to my attention formal demands made by attorneys claiming to represent the Cameron Septic Tank Co., of Chicago, for royalties for the use of tanks in connection with the chemical disinfection of sewage.

While it is true that certain tanks used in connection with chemical disinfection to provide necessary storage and period of contact might, upon casual inspection of drawings, appear to be septic tanks and might even be operated as septic tanks by omitting the application of disinfectants, it must be apparent to anyone with the most elemental knowledge of sewage purification that the two systems of treatment are quite distinct. The septic tank is designed to encourage the multiplication of bacteria and the bacterial putrefaction of the sewage matter. Such tanks when properly designed are also effective sedimentation tanks. Chemical disinfection, on the other hand, aims at the partial destruction of bacterial life and the prevention of putrefactive changes, and a well-designed storage tank for disinfection purposes should reduce sedimentation to a minimum.

In view of what is evidently the present policy of the Cameron Company, therefore, it seems desirable to point out to users of chemical-disinfection processes the essential difference in these two systems, in order that they may not unwittingly enter into entirely unnecessary arrangements for the payment of royalties.

EARLE B. PHELPS.

Washington, D. C., Jan. 27, 1916.

Contractors Should Not Rely on Engineers' Estimates

Sir—I wish to call attention to the unintentional injustice done contractors by engineers who prepare inaccurate estimates of cost. At a recent letting of some 6,000 cu.yd. of 1:2:4 concrete carrying 130 lb. of steel to the yard, with additional items aggregating $15,000, the engineer's estimate was $70,000, when $110,000 would have been much more reasonable. The lowest bid made was an even $68,000 and was evidently intended to just slip under the engineer's estimate. In order to give others an opportunity to judge how much this job would cost, I present a résumé of the specifications and a summary of the material prices at the place in question:

The cost of standard cement f.o.b. cars was $1.50 per bbl., with the usual 10c. per bag refund. Each car of cement must be tested by a reputable testing laboratory and reported O.K. before being used; this clause required the storage of the cement for a period of at least three weeks. Expense of testing must be borne by the contractor. Standard gravel for the concrete must be washed and free from all foreign matter, even a trace of the latter being sufficient ground for rejection. Prospective bidders were offered either sand or gravel for 90c. per cu.yd.

The concrete work consisted of walls varying in height from 10 to 33 ft., with coping on both sides of the wall. Counterforts were placed every 10 ft., on one side of the wall. Some of the reinforcing rods had to be heated in order to make the bends, and the steel had to be wired securely at all intersections. The walls had to be waterproofed on both sides, using a home-made wash. Approximately ½ sq.ft. of waterproofing was required per cubic foot of concrete.

The wall was of a patented type, the specifications requiring the contractor to arrange for the royalty and stating further that, before the final estimate would be paid, the contractor must show receipt from the patentee to the effect that the royalty had been paid. The patentee's price for royalty was 10% of the bid price for the work.

The excavated material had to be backfilled in layers and tamped, this operation being taken care of in the unit price for excavation. The forms were to be of dressed lumber, free from loose knots, cracks and other defects, the specifications indicating that a first-class job was required.

Let us make an estimate for this piece of work, using the prices and specifications just mentioned:

Each cubic yard of cement will require 1.5 bbl. of cement at $1.40 net, plus 10c. for hauling, testing and storing	$2.25
Sand and gravel, 1.5 yd., plus 20% for waste, @ 90c.	1.62
Reinforcing steel, 130 lb. @ 3c.	3.90
Mixing and placing, including water and waterproofing	1.00
There would have to be about 1 sq.ft. of forms for each cubic foot of concrete, and at 10c. for each foot of contract surface the price would be	2.70
Overhead expense, superintendent's office, night watchman, timekeeper, telegrams, telephones and postage	.50
Profit	1.50
Royalty	1.50
Total	$14.97

This estimate is fair from the standpoint of both parties, yet the engineer's estimate was $7.65 per cu.yd., which included cement, sand, steel, forms, waterproofing, labor, royalty and, last and of course least, profit. What items in our estimate can be materially lowered or cut out entirely without departing from the specification requirements? The answer is, "Profit."

At the letting in question a contractor filed his bid with a certified check for $5,000. His figure was $68,000, with an interlineation that this did not include the royalty. Is it not probable that this bidder counted upon the engineer's estimate being a fair one and carrying at least 10 to 15% profit? He was anxious for work, no doubt, and willing to take the job at slightly less than the engineer's estimate. In the last two years there have been brought to my attention many instances where the bidders have just shaved the estimate a few hundred dollars and then filed their bids without attempting to make even a rough estimate of the probable cost.

ONE OF THE BIDDERS.

Columbus, Ohio, Jan. 2, 1916.

Otay Rock-Fill Dam Failure

By Charles Whiting Baker

SYNOPSIS—A rock-fill dam 130 ft. high, which depended for water-tightness on a riveted steel-plate diaphragm, was destroyed by flood Jan. 27, causing much loss of life and property. Personal observations of leaks and other features made during a visit to the dam three months ago are given, together with a report on the failure.

On Thursday afternoon, Jan. 27, the Lower Otay rock-fill dam of the San Diego water-supply failed, and the contents of the reservoir, amounting to 13,000,000,000 gal. were discharged down the valley, causing a flood in which some 30 lives are reported to have been lost.

The writer visited the Lower Otay dam on Oct. 27, 1915, in company with Allen Hazen, Consulting Engineer, and John L. Bacon, Assistant City Manager of San Diego, in charge of the Department of Water-Supply. The following description of the structure is prepared from information secured at that time. The dam was fully described at the time of its construction, in *Engineering News* of March 10 1898, and has been described also in the late James D. Schuyler's well-known treatise on "Reservoirs." In some important respects, however, the actual construction of the dam differs from the published descriptions, nothwithstanding the fact that the article in *Engineering News* was prepared by the engineer in charge of the work.

The dam is a rock-fill structure that has at its center a steel plate embedded in cement mortar, forming a diaphragm which is the sole reliance for water-tightness. It was the first dam of this peculiar design ever built, and only a very few others of similar design have been constructed. The originator of this design was not an engineer, but a promoter and financier, E. S. Babcock, at that time president of the Southern California Water Co., which completed the structure in the year 1897. Mr. Babcock not only originated the plan of building the dam in this manner, but directed how the work should be carried on.

The Otay River is a small stream, less than 25 mi. in total length, which empties into the southern end of San Diego Bay, and like all rivers in southern California is entirely dry during the summer season. The Lower Otay dam is located at a natural reservoir site about a dozen miles southeast of San Diego. At the lower end of a broad valley the river cuts through a high dike of porphyry in a narrow cañon. By building a dam 130 ft. high at the head of this cañon it was possible to flood an area of 869 acres and store 13,000,000,000 gal. of water. The drainage basin tributary to the reservoir has an area of about 100 sq.mi.

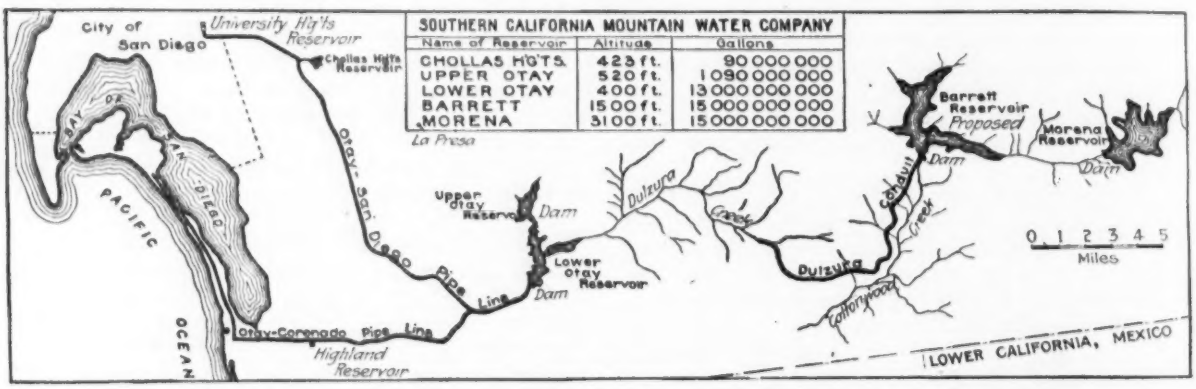


FIG. 1. SKETCH MAP OF RESERVOIR SYSTEM FOR WATER-SUPPLY OF SAN DIEGO

Rock-Fill Structure with Steel Diaphragm

In view of the failure of the dam, with distressing loss of life and large damage to property, it is important to engineers that the facts concerning it should be widely known. Especially is it important to mention that at the time of the writer's visit, months before the recent failure, engineers of standing in San Diego who were familiar with the construction of the dam frankly expressed their disapproval of the structure, not indeed on account of its lack of safety, but for other reasons. It may as well be set down at this place that one chief objection to the peculiar design of the dam is the impossibility of determining with accuracy its margin of strength.

Masonry Dam Was First Proposed

In constructing the dam a masonry foundation was carried down to a depth of 31 ft. below the stream bed, with a maximum thickness of 65 ft. It was originally intended to build the structure as a masonry dam throughout; but when the masonry had been carried up to a height of 8 ft. above original water level, or 45 ft. above the lowest point of the masonry, Mr. Babcock decided to make the rest of the structure a rock-fill with a steel plate core. The steel plates used were ⅓ in. thick for three courses at the bottom and ¼ in. thick above and were riveted together to form a continuous diaphragm. The lower course of plates was riveted to an inverted T of iron or steel, which was bolted to the masonry. Had this steel diaphragm been embedded directly in a heavy concrete core wall, better results might perhaps have been obtained; but at that time knowledge as to the preservative effect

of concrete on steel embedded in it was not widely disseminated, and Mr. Babcock decided to protect the steel diaphragm with an asphalt and burlap covering.

As the diaphragm was built up, it was mopped with hot asphaltum and a layer of burlap was placed against

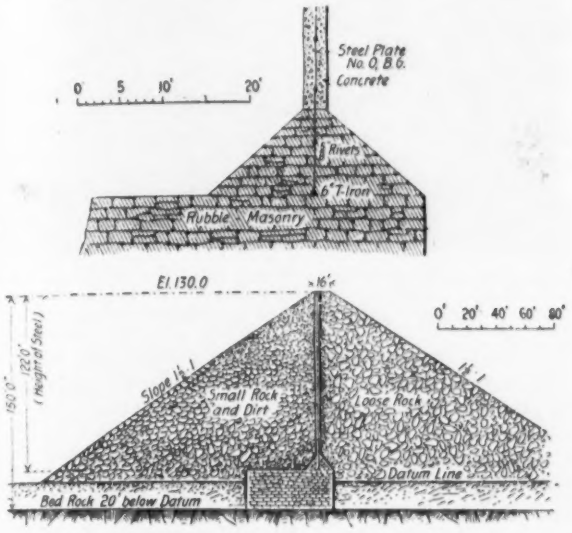


FIG. 2. CROSS-SECTION OF LOWER OTAY DAM AND ENLARGED SECTION OF STEEL CORE WALL AT BASE

Reproduced from "Engineering News," Mar. 10, 1898; dimensions of dam as built vary from this

it and held in place by boards. Then a thin wall of cement masonry, about a foot thick, was carried up on each side of these boards, being held between wooden forms which were left in place. The rock was deposited directly against the concrete as the dam was built up. The purpose of the concrete was rather to protect the steel from mechanical injury than to keep water away from the steel.

According to information furnished the writer by those directly connected with the work of construction, slap-dash methods were pursued. The rock was excavated by huge blasts in the cañon walls just below the dam and was deposited in the dam by cableway. The steel-plate diaphragm was built up often considerably in advance of the concrete covering. Being exposed to the intensely hot sun of southern California, the top of the diaphragm expanded and assumed a series of curves, so that it was impossible to do a good job in holding the layers of asphalt, burlap, boards and concrete against the steel. There was of course no way in which to determine whether the riveting and calking of the diaphragm was a water-tight job.

In depositing the rock the finer material was placed on the upstream side and the large pieces on the downstream side, but this was merely to secure as much strength as possible on the downstream side. It is not surprising under the conditions above recited that the dam was not water-tight. It has always leaked. It has been claimed that the leakage is through seams in the porphyry rock in which the dam is founded, but there was no means of ascertaining how much of the water might be coming through the steel diaphragm.

Leaky Dam Doubly Serious at San Diego

Leakage through a dam is always objectionable, but on the San Diego water-supply it is a very serious matter. The average annual rainfall at San Diego is only 9 in. per annum and only some 13 in. on the Otay drainage basin. The annual rainfall, however, is subject to great variation, as was shown by the curves accompanying the paper by Allen Hazen, on variation in annual rainfall, published in *Engineering News* of Jan. 6, 1916. During three successive years, from 1901 to 1904, the annual rainfall at the Sweetwater dam, a half dozen miles away on the next stream north of Otay, averaged less than 5½ in., and there was no runoff whatever into the reservoir. That is why leakage of the water stored for San Diego's use is a serious matter.

According to the last annual report of the San Diego water department, the daily leakage from the Lower Otay dam was 225,000 gal.; but the writer was told at the time of his visit last October that the leakage was as much as 400,000 gal. a day. In order to save this water a sump and a pumping plant operated by a 50-hp. oil engine were built below the dam in 1913 to pump back into the reservoir the water that leaked through the dam.

It will be at once recognized that the entire strength of the dam to resist the water pressure against it lies in its lower half below the steel diaphragm, for the porous fill on the upper side admits the water freely. Further, this lower half of the dam has to act as a retaining wall to sustain the pressure of the upper half of the dam in addition to the water pressure.

The accompanying cuts, reproduced from the article published in *Engineering News* of March 10, 1898, show a structure with slopes of 1½ horizontal to 1 vertical, but the slopes of the dam as actually built are steeper than this. The writer was distinctly impressed

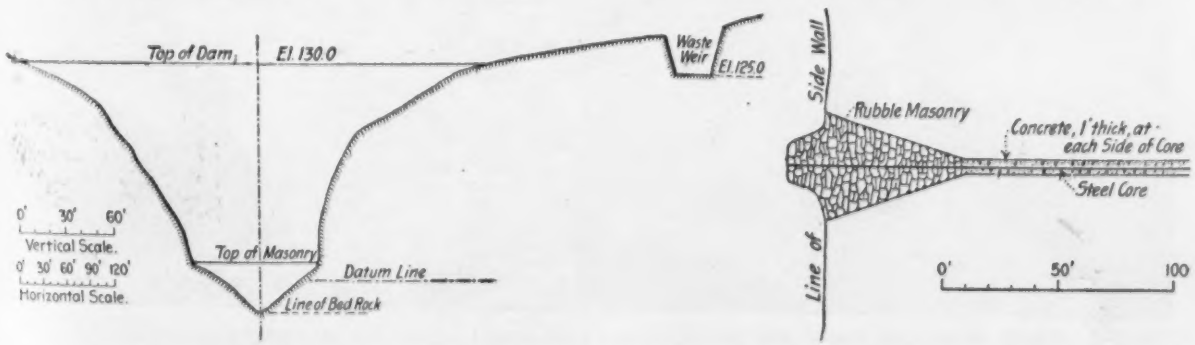


FIG. 3. PROFILE OF GORGE IN WHICH DAM IS BUILT AND SECTION SHOWING WIDENING OF MASONRY BASE ON THE LINE OF THE SIDE WALL OF THE DAM

at the time of his visit with the steepness of the downstream slope of the dam for a rock-fill structure. It appeared as if the rock had been dumped there on a slope about as steep as the material would stand. Mr. Hazen had the same impression. The rock on the downstream slope was left, apparently, just as it dropped from the cableway used in construction. Schuyler, in his "Reservoirs," states that the downstream slope is "about 1 to 1," but that the finer material on the upstream face had assumed about a 1½ to 1 slope.

The top of the dam was originally designed to be 20 ft. thick, but Schuyler states that, as first built, the thickness was about 9 to 12 ft. When the spillway was built, the material excavated was dumped on the upstream slope and the top width was somewhat increased.

Belated and Inadequate Spillway Provided

Building a dam without a spillway is a good deal like building a boiler without a safety valve, and it is a particularly noteworthy illustration of the ideas prevailing in the construction of the dam that no spillway whatever was made until the dam had been completed for two years.

The spillway is excavated through solid rock near the east end of the dam. It is 38 ft. wide and extends for 380 ft. through a rock bluff. It is lined with concrete and has a rather flat slope. The floor of the spillway is at El. 124.2 ft. above the original stream bed, and the original height of the crest of the dam was 130 ft., giving a depth of 5.8 ft. of water in the spillway before the dam would be overtopped. It is probable, however, that the crest of the dam has settled somewhat since its completion.

The sole means of drawing water from the reservoir above the dam is the outlet tunnel for the San Diego water-supply, 5 ft. in diameter, which leaves the reservoir 82 ft. below the dam crest. Nothing in the way of blowoff pipes or emergency relief outlets other than the spillway has ever been provided, and there is not even provision for drawing the city supply from different reservoir levels.

There was great delay in obtaining definite particulars as to the manner in which the dam failed, owing to the destruction of wire communications and the blocking of roads by the washing away of bridges. The

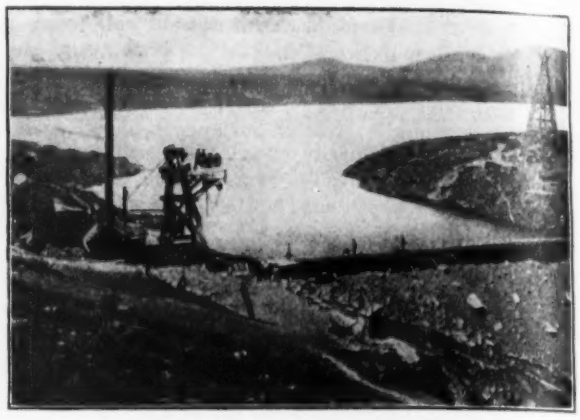


FIG. 4. VIEW OF LOWER OTAY DAM UNDER CONSTRUCTION

From "Engineering News," Mar. 10, 1898

reports of flood destruction over a widespread area of southern California, however, indicated that the rainfall must have been of an unprecedented character for that section.

The crest of the Lower Otay dam was about 480 ft. above sea level. In its flow from there to San Diego Bay, some miles distant, the flood would inevitably cut a wide channel of destruction and sweep away every dwelling in its path. The country along the lower Otay River is sparsely inhabited, or the loss of life would have been much greater.

The San Diego Water-Supply Situation

Not the least serious aspect of the disaster is the loss by the City of San Diego of its main source of water-supply, for the emptying of the Lower Otay reservoir makes it impossible for the city to draw upon the reserves of water stored in the Morena and Upper Otay reservoirs. For immediate needs, however, the city can draw about 5,000,000 gal. per day by means of its pumping plant, taking water from wells in the Mission Valley on the lower San Diego River a few miles north of the city. The remainder of the city's consumption (its total requirements are about 10,000,000 gal. per day) can probably be furnished by the Cuyamaca Water Co., which supplies water to some outlying suburbs and furnished a considerable amount of water to San Diego in 1914.

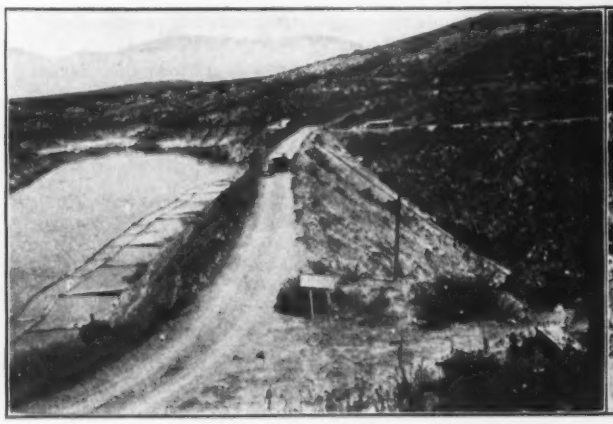


FIG. 5. LOWER OTAY DAM FOR SAN DIEGO WATER-SUPPLY ON OCT. 27, 1915

This view and Figs. 6 and 7 are reproduced from photographs taken by Allen Hazen, Oct. 27, 1915

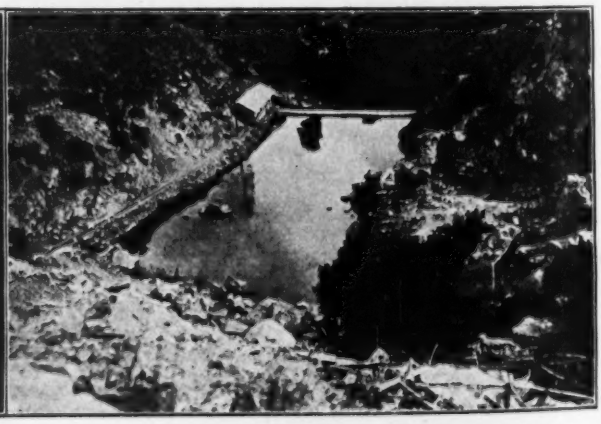


FIG. 6. VIEW OF DOWNSTREAM FACE OF LOWER OTAY DAM

Showing pool for impounding leakage and pumping house and pipe line delivering it back into reservoir

The yield of the Mission Valley wells, however, falls off as the dry season advances, and the Cuyamaca Water Co. has other imperative demands on its rather limited storage. San Diego will therefore need to proceed with the utmost dispatch to provide water from other sources. An emergency pipe line could be built from the city conduit to the Sweetwater reservoir, and probably the Otay Dam will be rebuilt at once.

Latest Account of Dam Failure

The following account of the failure of the dam was received by wire on Feb. 1 from John L. Bacon, until recently Assistant City Manager of San Diego:

The heaviest rainstorm ever recorded in this part of California caused the destruction of the Lower Otay dam at about 5 p.m. on Jan. 27. The rain began on Jan. 14 and continued for six days, with an average precipitation of 1 in. daily. Upon the ground thus thoroughly saturated a second and much heavier rainstorm fell on Jan. 25. The rain gages were inadequate to measure this storm, and the actual rainfall record at the dam is not available. The precipitation on Jan. 27, however, is estimated at about 5 in., a cloudburst occurring about 4 p.m.

The level of the water in the reservoir rose 9½ ft. from 7 a.m. to 5 p.m., at which time the dam overflowed. It began to give way about 5 min. later. The destruction was completed in 15 min., the dam being washed away to its foundations all around. The failure evidently started by the water overflowing the crest, washing out the backing of the central core. The break started near the center of the dam,

FIG. 7. SPILLWAY OF LOWER OTAY DAM FOR WATER-SUPPLY OF SAN DIEGO

the plates holding back for a time against the sides. Part of the plate was crumpled up and washed down the valley for several miles.

The floor of the spillway was at an elevation of 124 ft. above the original stream bed, and the elevation of the top of the dam was 134 ft. The spillway was 38 ft. wide at the bottom and 45 ft. wide at the elevation of the dam crest. The estimated flow through the spillway when the dam overflowed was 2,000,000,000 gal. daily. The spillway was not blocked in any way. The ¼-in. steel-plate core in the dam, with 12 in. of concrete on each side, stopped 2 ft. below the dam crest. The length of the dam crest was 560 ft. and the width of the top 16 ft. The thickness of the dam at the bottom was 400 ft. The valley below the dam was swept clear of soil to bedrock, and the banks of the valley show that a wave about 50 ft. high passed down. About 30 lives were lost in the flood.

It is estimated that to replace the dam will cost about half a million dollars. There is ample water for the city's supply stored behind several other dams. Part of the Sweetwater dam was washed out. The Upper Otay dam, an arched concrete structure of horseshoe shape, had a depth of 3 ft. of water flowing over its crest on Thursday, but is safe. The City of San Diego has been cut off from the outside world except by water. No telegraph, telephone or railway lines were in operation. All bridges were washed out, and roads were impassable.

Floods in Southern California Summarized to Jan. 25*

Beginning Sunday, Jan. 16, 1916, southern California was visited by a rainstorm the intensity of which caused high-water conditions throughout the section. The resulting floods did much damage, tying up and delaying traffic on most of the steam railroads and electric lines and rendering many families homeless. Several deaths are also attributed to it. The storm center occurred at the latitude of Los Angeles and not to the northward in the vicinity of Point Conception, as is usual.

The rainfall recorded by the United States Weather Bureau at Los Angeles, covering the four days of Jan. 16 to 19, was 6.52 in. The greatest rainfall for 24 hr. was on Monday, Jan. 17, when 4.16 in. was measured. The heaviest hour's precipitation was between 3 and 4 a.m. of that day, when 0.83 in. fell. The magnitude of the floods was largely due to the fact that during the first 15 days in January it had rained 3.29 in., which was distributed over seven rainy days, saturating the soil.

This storm is comparable with that of February, 1914, which caused severe flood conditions generally throughout southern California. The total precipitation of that storm (February, 1914) was 7.04 in., practically all of which fell in a period of three days, the greatest rainfall for 24 hr. being 4.26 in. on Feb. 18. The greatest intensity for any one hour was on Feb. 18, when 1.49 in. was recorded between 1 and 2 p.m. This 1914 storm, like the recent one, was preceded by several rainy days. The flood damage caused by the storm of 1914 was greatly in excess of that caused by the late storm.

Floods in southern California are of a "flashy" nature and emerge from the mountain cañons with great violence, carrying heavy loads of silt. Near their mountain outlets these floods erode violently. In the low lands, where the stream gradients are flat, they overflow and deposit silt on their delta cones. Large areas were flooded by the last storm to a depth of from 1 to 4 ft., and damage resulted in the vicinity of Los Angeles and Long Beach harbors from the deposit of débris.

Some of the streams were gaged during the height of the recent flood. South of Los Angeles the west flood channel of the San Gabriel River unites with the flow of the Los Angeles River and the Arroyo Seco. This combined flood flows southwesterly between the Dominguez and the Cerritos hills.

On Jan. 18, 1916, the combined flow was 31,100 sec.-ft. Of this stream approximately one-half was flowing southerly into the harbor of Long Beach. The remaining portion traveled southwesterly into the Los Angeles harbor at Wilmington, where it deposited silt to such an extent that a large ocean-going steamer in dock was grounded and the efforts of four tugs were necessary to extricate it from its position. The recent adoption of the plan for the diversion of these streams to a new outlet into the ocean, both by the army engineers and the Los Angeles County Board of Flood Control, is timely.

Measurements were made on Jan. 19, 1916, of the Los Angeles River and the Arroyo Seco above the City of Los Angeles. The maximum discharge of the Los Angeles River was roughly estimated to have been 7,200 sec.-ft., and that of the Arroyo Seco 6,200 sec.-ft. Measurement

*From the Engineering Offices of J. B. Lippincott, Central Building, Los Angeles, Calif.

was made by the United States Geological Survey of the San Gabriel River at Azusa between 11 a.m. and noon of Jan. 19, 1916, and showed a flow of 4,310 sec.-ft. The peak of the flood probably occurred on Jan. 17.

The San Luis Rey River in San Diego County discharges into the Pacific Ocean at Oceanside. This river has a drainage area of approximately 600 sq.mi. While the rainfall on the seaboard at San Diego is usually light, it is heavy in the higher mountain elevations, a rainfall of 46 in. per annum being recorded at Nellie, which is at El. 5,500 ft., approximately, on the crest of the San Luis Rey basin. At Escondido the annual precipitation is 14.89 in. Four and one-half inches of rain was recorded on Jan. 17, 1916, at the intake of the Escondido canal, at an elevation of 1,700 ft. The crest of the San Luis Rey flood of 27,000 sec.-ft. reached the mouth of the river about noon of that day. Soundings were taken from the highway bridge at Oceanside and float velocities observed. These showed during the morning of Jan. 19 a discharge of 9,500 sec.-ft., and during the afternoon 10,000 sec.-ft. The river washed out bridges at Bonsall, about 15 mi. from its mouth, and at San Luis Rey Mission, 4 mi. from its mouth. The railroad bridge north of Oceanside was washed out, and train service on the Santa Fe line between Los Angles and San Diego was suspended from Jan. 17 to 25. The Los Angeles-San Diego highway was washed out in a number of places near Los Angeles, at Cardiff and at Bernardo.

High floods occurred along the coast streams as far north as San Luis Obispo and from the high Sierras as far north as Fresno. North of this there appears to have been either less precipitation or snowfall—which does not promptly produce high water.

Drainage of Railway Roadbeds*

By M. C. Blanchard†

The importance of proper and adequate drainage for railway roadbeds has always been realized, but the rainy season of 1915, because of its length and the extraordinary precipitation, has served to emphasize that fact to those actually engaged in the maintenance of track.

Ordinarily the usual methods of drainage, such as cut and surface ditches, when properly maintained, are sufficient to carry off the surface water and provide a fairly well-drained roadbed. Frequently conditions occur, however, when these ordinary means are inadequate, and it is then necessary to provide special systems of drainage to carry away the water that sinks into the roadbed.

The most common condition requiring these special systems is the formation of a pocket or bed of porous material of considerable depth underlying the track, into which surface water sinks and is imprisoned to a greater or less degree by the adjacent earth. This condition occurs in both cuts and fills and usually is brought about in the following manner.

Formation of Ballast Pockets in Cuts

In cuts the ditches frequently become blocked by dirt that washes or slides in from the sides. The surface water is thus prevented from escaping and gradually sinks into the roadbed, making it soft and spongy. Occasionally this same condition is caused by springs or seepage occurring in deep cuts. The subgrade, thus softened, is not able to support the track and the heavy loads to which it is subjected. The result is that track and ballast are forced down, displacing the underlying earth, which heaves up in the ditches in the cut at each side. When this happens, the track is brought up to its former level on ballast, and eventually the track forces remove the displaced earth and clean out the ditches. When this is repeated year after year, the track finally becomes underlain for a depth of several feet with a material much more porous than the adjacent earth, and into this material water pours without any means of escape.

FIG. 1. TILE-DRAIN CONSTRUCTION IN CUTS

FIG. 2. BALLAST POCKET UNDER RAILWAY ROADBED
This same pocket with rock drain in place is shown in Fig. 5

*From a paper read at Kansas Engineering Society meeting, Jan. 19, 1916.

†Engineer, eastern district, Atchison, Topeka & Santa Fe Ry., Topeka, Kan.

In fills this same condition is caused in several ways. Frequently there is insufficient allowance made for the shrinkage of embankments, and the track, when it settles below the established grade, is raised on cinders or ballast. In a great many instances the original embankments are not built with slopes flat enough to prevent slides, when the filling material becomes more or less saturated under heavy rains. These slides in many cases extend back to or under the track and are temporarily repaired by dumping in cinders or ballast to the extent of making the track passable. Again this condition may be brought about by the continual raising of the track on ballast, as it is surfaced from time to time.

In all of these cases the shoulders of the embankment are usually brought up with earth secured at a time and in a manner most convenient to the track forces. The result, however, is the same as in the cut, in that the track becomes underlain with a stratum of porous material inclosed within more or less impervious earth.

The results of this condition are to make it almost impossible to maintain track in proper line and surface,

FIG. 3. TYPICAL SLIDE IN FILL, JUNE, 1915

even with a large continual expenditure of money for track labor, and in the case of embankments to cause continual slides. These slides are caused by the water collecting in the porous pockets, then seeping out through the fill, thus saturating a plane extending from the bottom of the pocket to the outer face of the embankment, upon which the superimposed material easily slips.

Remedying Pocket Conditions in Cuts

To alleviate or remedy in cuts the conditions referred to, the Atchison, Topeka & Santa Fe Ry. during the past year has been using on its eastern district a system of tile drains which may be briefly described as follows: The side of the cut is produced down to a point about 3½ ft. below subgrade to form one side of a ditch, in which is laid the main tile. The other side of the ditch is formed by a plane extending from the upper side of the end of the track tie, with an approximate slope of 1 in 1, until it intersects the plane 3½ ft. below subgrade. Using the Santa Fe standard roadbed, this results in a ditch about 3 ft. deep, 1 ft. wide at the bottom and 7 ft. wide at the top. In this ditch is placed the main drain, which usually is a 6-in. vitrified tile, with bell ends. Connected to the main by means of tees are 4-in. laterals spaced 16½ ft. apart and extending usually to a point between the rail and the center of the track. These laterals are laid so as to tap the bottom of the ballast or cinder pocket. The appearance of several of such pieces of construction may be noted in the accompanying views.

FIG. 4. ROCK DRAIN TO PREVENT REPETITION OF SLIDE SHOWN IN FIG. 3

In most instances a main drain is laid on each side of the track, and the laterals are staggered so that one lateral occurs in every 8¼ ft. of distance. The lateral trench is usually backfilled with the same material with which the track is ballasted, while the main ditch is filled with cinders. The surface is made to conform to the bottom of the original ditch. The ballast is then redressed to the standard cross-section, and the job is complete.

For draining the pockets in embankments the Santa Fe has been using trenches filled with broken stone,

FIG. 5. BALLAST POCKET SHOWN IN FIG. 2 WITH ROCK DRAIN

known in highway work as French, or rock, drains. These trenches are usually from 3 to 4 ft. wide, ordinarily at right angles to the track and extending to a depth sufficient to drain the troublesome pocket. In some cases they extend entirely through the fill, and in other cases only from about the center to one face of the embankment, depending upon the size, location and character of the pocket to be drained. The distance they are spaced apart also depends upon these same conditions and is

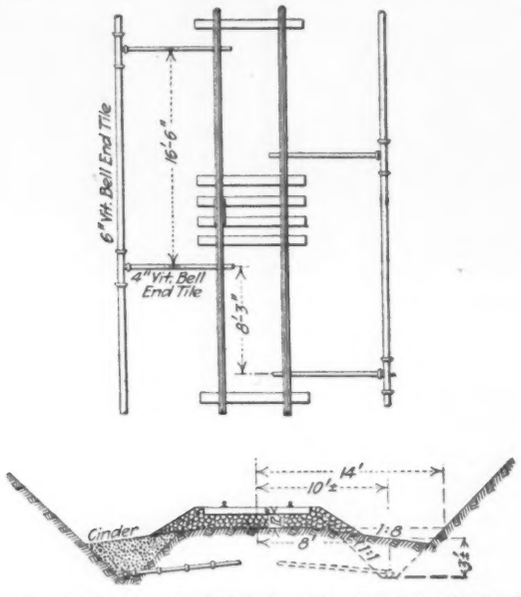


FIG. 6. DETAILS OF TILE-DRAIN CONSTRUCTION FOR DRAINING RAILWAY ROADBEDS

determined by the engineer from an examination of the ground.

The bottom of the trench is made with sufficient grade to insure the flow of water from the pocket to the face of the embankment. (This grade should be made great enough so that slight future settlement of the embankment will not destroy its effectiveness.)

The rock used for filling the trench is usually one-man-size riprap. In some of the drains that have been built, rock of this size has been carried up to within 1 ft. of the top of the trench and the remainder filled with crushed rock of the size used for ballast. This was done on the theory that the finer rock on top would prevent dirt from sifting in and gradually filling the interstices in the larger-sized rock.

There have been several places where conditions were such as to afford very poor means for carrying water away from the foot of the embankment, and in such cases a lateral drain has been constructed at the foot of the slope, into which the cross-drains connect. The lateral drain is similar in construction to the cross-drains and carries the collected drainage into the nearest ravine or depression of sufficient depth to carry the water away from the roadbed.

Problems in Draining Pockets in Fills

In places where the fill is light and the pocket or stratum to be drained is not deep—a condition that is usually caused by the repeated raising of the track in resurfacing from season to season and the consequent raising of the shoulder with earth to permit standard ballast dressing—the drains installed are ordinarily smaller than those mentioned. They are generally about 2 ft. wide and filled with spalls or rock smaller than one-man-size riprap. In other places where fills are very heavy or where sidehill construction is encountered and the drainage conditions are so bad as to make it impossible to keep the road in operation on account of slides, the drains, particularly those used as laterals, have been made much larger than any of those previously described, and they serve the purposes of a wall for bracing or retaining the roadbed, besides acting as a drain.

It has frequently been found necessary to flatten the slopes of embankments, as well as to install these drains, to prevent entirely the occurrence of slides. Very often the nature of the earth is such that it will not stand on a 1½ on 1 slope, as is usual in the construction of embankments, and in such cases the installation of drains will not wholly avert slides. On the other hand very flat slopes show a tendency to slide where porous pockets exist under the track, and therefore in such cases a combination of flat slope with rock drains should be used.

The performance of these systems of drainage has been very satisfactory. The amount of water drained from th roadbed by them for a long time after rainfall has ceased is surprising. The cost of these systems is greater than of those ordinarily used, but it is justified by the better and safer track obtained and the decreased cost of maintenance.

Why the Seattle Wood-Stave Water Pipe Failed*

By R. H. Ober†

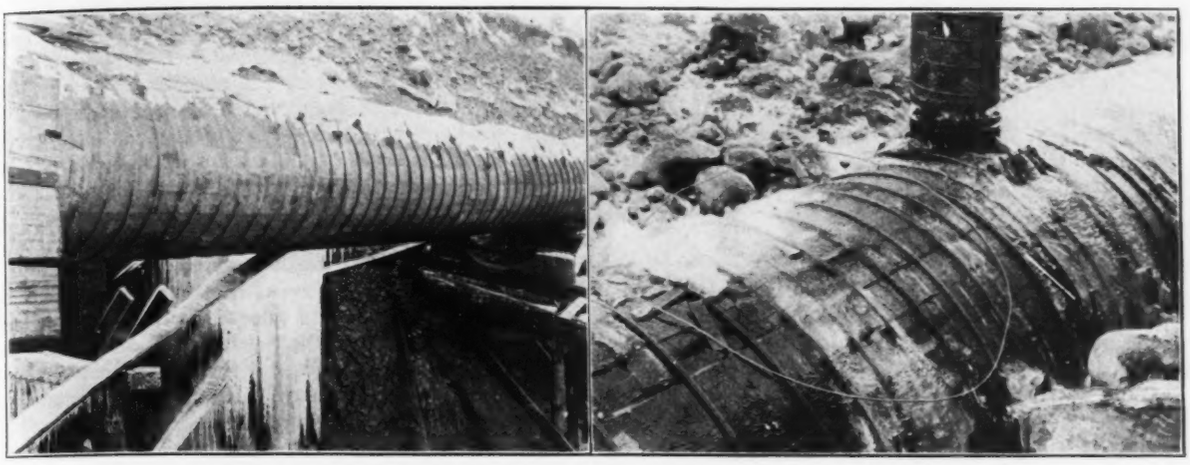
Seattle is supplied with water from Cedar River by means of two wood-stave pipe lines—Cedar River Pipe Line No. 1 and Cedar River Pipe Line No. 2. Pipe Line No. 1 was constructed in the year 1900 and put into operation on Jan. 10, 1901. Pipe Line No. 2 was constructed in the years 1908 and 1909 and was put into operation on June 21, 1909. It was in this latter pipe line that the recent breaks occurred which cut off a portion of the city's water-supply [early in January, 1916.]

The first leak appeared at Grouse Ridge, about 4 mi. from the intake at Landsburg; the second at a point near Rock Creek, about 2½ mi. below the intake; the third near the station of Noble, on the main line of the Chicago, Milwaukee & St. Paul R.R., at a point about 2 mi. below the intake; and the fourth in the vicinity of Molasses Creek, which is between Swan Lake and Renton and about 11 mi. from the intake. All of these leaks occurred in the immediate vicinity of standpipes located at summits in the pipe lines.

The first and fourth leaks were of a comparatively minor nature, involving a relatively small amount of work in the replacement of one or more staves which were not decayed, but which were defective when originally built into the pipe. The second and third leaks, however, were of a very serious nature, involving material injury to the

*A report made to the Pacific Coast Pipe Co., Seattle, Wash., which engaged the author of the report to investigate the breaks in order to learn their exact course. The author of the report was accompanied by L. M. Grant, chief engineer of the company. The company did not furnish the material for the conduit nor construct the latter.

†Consulting Engineer, Alaska Building, Seattle, Wash.; formerly City Building Inspector of Seattle.



FIGS. 1 AND 2. WOOD-STAVE PIPE LINE NO. 2, WATER-WORKS OF SEATTLE, WASH., at BREAK NO. 2, NEAR ROCK CREEK

Left—Hillside support washed from beneath pipe. Right—Portion of 150 ft. of conduit after rebuilding

pipe line and reconstruction in each case of a considerable length of pipe. The water contained in the standpipes in the vicinity of the second, third and fourth leaks had been frozen, and the standpipes had thereby been rendered incapable of performing their proper functions. The freezing of these standpipes made it impossible for air to enter the pipe lines to take the place of the water that was drawn off in cleaning the settling basin at Landsburg and in repairing the first leak at Grouse Ridge. This resulted in the formation of a vacuum in the vicinity of each of these standpipes and the consequent collapse of the pipe by reason of the unbalanced atmospheric pressure upon the outside of the pipe.

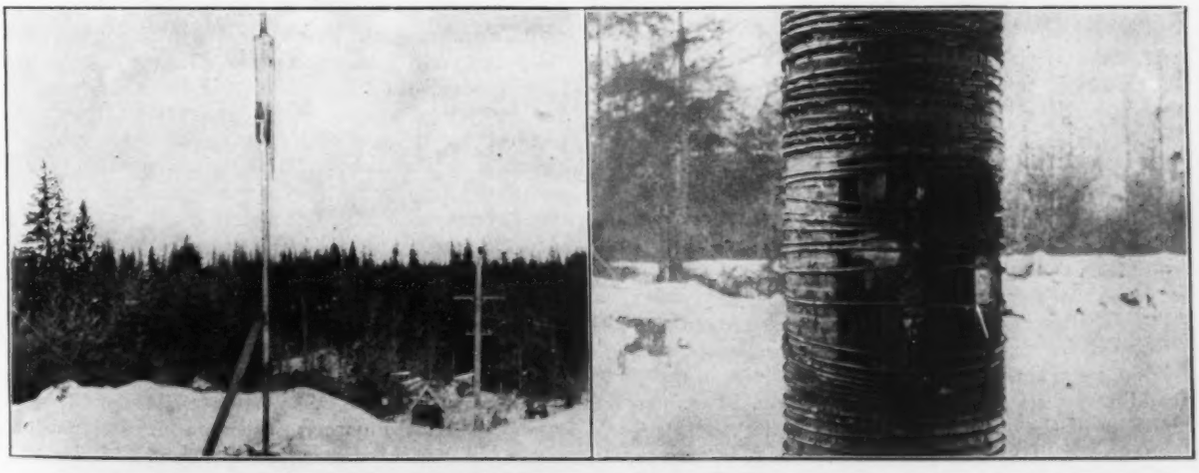
With the repair of the first leak at Grouse Ridge and the subsequent admission of water to the pipe line the escape of the water from the broken pipe in the vicinity of Rock Creek became noticeable and resulted in the washing out of the hillside at that point before the water was shut off at the intake. (See Figs. 1 and 2 for views of conduit before and after the break was repaired.)

With the repair of this section of the pipe and the subsequent admission of water into the pipe line, the damaged condition of the collapsed pipe at the third leak, in the vicinity of Noble, became noticeable through the escape of the water and the washing out at the hillside at that point. Subsequent to the reconstruction of the collapsed pipe at the third break, near Noble, the fourth break, in the vicinity of Molasses Creek, was discovered and repairs were made at this point.

It is found that the wood staves of which pipe line No. 2 is constructed, which have been in service for a period of about seven years, are in very good condition, as shown by those exposed to view and by those removed from the broken sections. The outer surface of the wood, generally speaking, shows scarcely any signs of decay; where decay is to be seen, it is relatively small in amount and extends to a depth not exceeding $\frac{3}{16}$ in. at any point observed.

It is believed that the injury to the pipe was not occasioned by the decay of the wood staves of which the pipe is constructed, nor by reason of the fact that the pipe was constructed of wood instead of some other material.

The formation of a vacuum as a result of the freezing of the standpipes would have caused the collapse of a steel pipe or of a reinforced-concrete pipe as surely as of the wood-stave pipe, and the repairs that would have



FIGS. 3 AND 4. INSULATION AGAINST FREEZING BURNED OFF STANDPIPES ON SEATTLE WATER-SUPPLY CONDUIT NO. 2

Left—Standpipe 2 mi. below intake. Right—Standpipe 11 mi. below intake

been necessary in the case of the steel or reinforced-concrete pipe would have required a much longer time and larger expense than in the case of the wood-stave pipe.

It is believed that the injury to the pipe lines and the consequent interruption of the water-supply of Seattle were due to lack of care in the construction of the standpipes and to failure to prevent the water in these standpipes from freezing.

The construction of the standpipes was defective by reason of the fact that the pipes were very much smaller than should have been installed, being, in fact, in some cases about one-seventh of the area which should be provided in order to afford reasonable protection against accidents of this kind. Lack of care was shown by the failure to protect the pipes in such a manner that there would be no possibility of the freezing of the water contained therein.

The fact that the water in those standpipes was frozen should have been discovered by the person or persons charged with the responsibility of protecting the water-supply of Seattle and should have been discovered in time to permit thawing out the standpipes before shutting off the water in the pipe lines. After the damage had occurred, it was evidently discovered that the water in these standpipes was frozen, and efforts were made to thaw out the pipes by means of building fires on the ground around them and by the use of oil applied to the standpipe within the outer casing. These fires at several standpipes destroyed what protection had been afforded by means of wooden boxes inclosing the standpipes, which boxes were filled with sawdust (see Figs. 3 and 4). The destruction of these boxes left the standpipes exposed to the weather and in a worse condition than existed before the occurrence of the breaks in the pipe lines, and they were allowed to remain in this exposed condition after the repairs to the pipe line had been completed, thus exposing the city to the danger of a further collapse of these pipes and the consequent interruption to the water-supply.

Finally, I would say that the conditions which brought about the injury to the pipe line, the consequent inconvenience to the people of Seattle and the hazard to life and property could have been avoided under a proper system of management and supervision and that without proper management and supervision similar injury would be caused, under similar conditions, to a pipe constructed of steel or of reinforced concrete.

News of the Engineering World

Civil Engineers To Vote on New Headquarters

As announced in the last issue of *Engineering News*, the Board of Direction of the American Society of Civil Engineers is sending out to the membership a circular explaining the proposal to transfer the society's headquarters in New York City to the Engineering Societies' Building on West 39th St. The board states that this question is perhaps the most important that has ever come before the society for decision.

Twelve years ago, at the time the Engineering Societies' Building was constructed, the American Society of Civil Engineers was invited to join with the three other great national societies of Mechanical, Electrical and Mining Engineers in joint ownership and occupancy of the new building. The civil engineers decided at that time not to accept the offer, but to continue to occupy their own house on 57th St., which they had built about eight years earlier.

At that time there was doubt among many members of the American Society of Civil Engineers as to the success of the scheme for accommodating the national engineering societies in a single great building. Experience has shown that most of the reasons which were urged a dozen years ago by members of the American Society of Civil Engineers against joining the other societies in the great building project are no longer controlling. The financial stability of the engineering building enterprise has been established. The 12-story building, which is now owned jointly by the three societies previously named, represents an investment of about $2,000,000. These societies own it free of all incumbrance and have in addition over $70,000 invested in a reserve fund to provide for depreciation and amortization.

The trustees who control the building for the societies have made two offers to the American Society of Civil Engineers. Under the first offer that society, by the payment of about $240,000, will become an equal partner with the others in the ownership and occupancy of the building, this sum being substantially equal to what the other societies have paid for their share of the property. Such room as the society needs will be provided on the sixth and seventh floors of the building. The sum paid by the civil engineers will be added to the present reserve fund, making a total of $330,000, in which, of course, the civil engineers would own a one-fourth interest.

The alternative offer is that an addition of 2½ stories shall be made to the top of the Engineering Societies' Building and that two of these floors shall be especially planned for the use of the American Society of Civil Engineers. The cost of this plan, it is estimated, will be no greater than that of the other plan and will not in any event exceed $250,000 The society would, as in the other plan, become an equal partner with the three other societies in the ownership and control of the building.

The libraries owned by the three other societies are already combined in one great engineering library. It is without doubt, of all libraries in the United States, the reference library most used by engineers, and through a system of correspondence it is made available for the use of engineers located anywhere in the world. It is proposed that the library of the American Society of Civil Engineers be added to this collection, which would make a total of about 150,000 engineering books. There is reason to believe that if this combination is made, a large endow-

ment will be provided to perfect further the facilities of the library for the use of engineers.

The present house of the civil engineers in West 57th St. has been appraised by experts at $325,000, of which, however, $290,000 is in the land and only $35,000 in the building, which has cost the society about $175,000. By the sale of its present property, the society could pay all the cost of its entrance to the Engineering Societies' Building, would have between $115,000 and $140,000 in its treasury and would own in addition an interest in the Engineering Societies' Building, valued at about half a million dollars.

In addition to the financial and business aspects of the proposition the Board of Direction remarks: "It is one of the purposes of this movement to strengthen the bonds of brotherhood which should exist between all engineers."

Further Notes on Kansas River Bridge Falsework Collapse

The accompanying photographs show the extent of the damage to the East Kansas Ave. bridge over the Kansas River at Kansas City, Mo. As reported in last week's issue of *Engineering News*, high water and floating ice pushed out some of the falsework bents under the suspended trusses of the bridge on Jan. 21.

The bridge was erected from the Missouri side (the far side in the views) and had been completed to the end of the cantilever arm on the Kansas side. The first three panels of the Kansas shore span had been partly erected on rather light separate pile bents under each truss when the ice flow carried away all but the two end bents, which were nearly at the shore line.

The north truss (on the left, Fig. 1) had been practically all assembled to its bent, which held sufficiently to prevent any visible damage to this truss; but the south truss had only the lower chord member resting on the falsework. This dropped 7 or 8 ft., eventually coming to rest on the two inner piles of the bent, the cap being

FIG. 1. KANSAS AVE. BRIDGE AFTER WASHOUT OF FALSEWORK
Looking toward Missouri shore. North truss on left

raised from the tops of the other three piles as shown in the views. The fall of the south truss caused the loss of six stringers and a 50-ton jack, which were on the superstructure, sheared off several pin plates and badly twisted the end floor-beam and crossbracing of the two end panels. These members had not been riveted, or the damage would have been greater, as the structure dropped by shearing off the bolt heads and breaking of pin plates without distorting many of the main members.

For the week following the collapse, rain and freezing weather made it impossible to work on the structure, and to Jan. 27 nothing had been done save to assemble some groups of piles under the distorted truss. The contractor proposes to drive groups of piles under this truss, cap them and bring the truss back into line by jacks.

FIG. 2. LOOKING NORTHERLY TOWARD KANSAS AVE. BRIDGE AT KANSAS CITY

Colorado River Flood at Yuma

An unprecedented flood in the lower Colorado River on Jan. 22 did much damage in Yuma, Ariz., and vicinity; and before the levee breaks could be repaired, there were indications that a still heavier flood might come down the river.

The possibility that the Colorado might break into the Imperial Valley once more caused much anxiety, but the first of the high floods passed by without doing any such harm. A summary of flood conditions in Yuma and vicinity up to Jan. 30 has been received by wire from L. M. Lawson, project engineer United States Reclamation Service, Yuma, Ariz., as follows:

The largest recorded discharge of the lower Colorado River up to that time occurred at Yuma on Jan. 22, when the gage stood at El. 34 and the discharge was 210,000 sec.-ft., besides an additional 10,000 to 15,000 ft. passing around Indian Hill through breaks in the main canal and Southern Pacific main line. This immense river flow was due to abnormal precipitation in the drainage area of the Gila River and to slight local rains on the Colorado drainage area. The heaviest previous discharge of the Colorado River at Yuma was 150,000 sec.-ft., during the regular June rise of 1909.

The Indian Reservation levee on the California side of the river was overtopped by 12 to 18 in. of flood water, causing three openings with a combined length of 800 ft. Through this break, water was discharged by means of the main canal of the Yuma Project of the United States Reclamation Service, through the high fill of the main line of the Southern Pacific and also through the lower reservation level. The project unit on the California side of the river totals 16,000 acres, of which 10,000 was under water. Main canal banks totaling 50,000 cu.yd. and levee banks amounting to 5,000 cu.yd. were displaced.

In the Yuma Valley unit of the project only 3,000 of 50,000 acres were flooded. An unforeseen high stage of water breached the Yuma Valley levee at 4-mi. and 16-mi. points, displacing about 12,000 cu.yd. of bank.

The levee protecting the City of Yuma constructed many years ago by the War Department, but not maintained, was partly destroyed. This permitted a large discharge of water through two principal streets of Yuma, doing considerable damage. Practically all the adobe structures in the flooded area of the city were completely ruined, and some buildings were rendered unsafe.

On Jan. 28 the river had fallen to El. 18 on the gage and the discharge to 36,000 sec.-ft., but reports indicated a second rise in both the Colorado and the Gila. Tonight [Jan. 30], with the gage reading El. 30 and the river discharging approximately 146,000 sec.-ft., it is believed that an unprecedented combination of floods in both rivers is coming.

The Laguna dam across the Colorado River is uninjured, and no irrigation structures of any size have been damaged. With a few exceptions the damage to farms is slight.

In the short interval between the two floods some levee breaks were repaired. The Reclamation Service is employing a large force and extra trains. Repairs to the canal breaks will be started at once. It is expected that water service [for irrigation] will be restored in 10 to 15 days.

The Imperial Valley levee breached for about 1,000 ft. at a point 5 mi. below the Imperial Canal heading, but the Inter-California R.R. embankment has thus far prevented damage to the Imperial Valley from water passing through this break.

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Decision Rendered Against Bone Cantilever Wall

A decision adverse to the Bone patent on reinforced-concrete retaining walls was rendered by Judge A. B. Anderson, of the United States District Court, in Indianapolis, on Jan. 26. The suit was brought by Frank A. Bone, the owner of United States Patent No. 705,732, against the County of Marion, Indiana, for alleged infringement of the patent in the construction of certain retaining walls by the county. The county introduced for the first time in any Bone case a number of foreign publications showing what were claimed to be anticipations of the Bone patent.

Judge Anderson gave an oral decision dismissing the complaint on the ground that the prior art disclosed walls embodying the essentials of the Bone wall. He said that the patent could obtain, if at all, only for the specific type of reinforcement shown in the application. The general design of reinforced-concrete retaining walls is a matter of longer standing than the Bone patent. The judge also gave as his opinion that the placing of reinforcing rods where tensile strain exists is not invention.

In the suit Prof. W. K. Hatt, of Purdue University, was expert for the County of Marion, and D. B. Luten, F. A. Bone, E. P. Bone and W. K. Eldridge were experts for the plaintiff.

⌘

The Final Vote on the Barge Canal referendum in New York State, excepting the vote from Oneida County, which is held up by court order, shows 615,147 votes for the $27,000,000 bond issue and 569,950 against, leaving a majority of 45,197 for the issue. The unofficial count for Oneida County showed a majority of 379 against the canal bond issue.

Maj.-Gen. Goethals Has Announced in an official statement that the Panama Canal is not ready to be reopened, nor can any prediction as to its prospective reopening be made. General Goethals says, among other things, "It is not intended to reopen the canal until a safe and practical permanent channel is reasonably assured. It is hoped that before long better information on the two main controlling features will be available. The large mass of rock at the base of Gold Hill on the east bank is being carefully observed. If the materials behind it move northerly, as is not unlikely, one danger of interruption to navigation will be removed. The other feature is the rate of motion that will result in the west slide when the dredges attack its face, as will shortly be done. As soon as this office feels that sufficient information on these two points is at hand to justify it, a prediction will be made. In the meantime it is recommended that the canal be not considered in the routing of shipping."

Heavy Rains in the Southwest on Jan. 30 and 31, particularly in Arkansas, the lower Ohio Valley and the Mississippi Valley from St. Louis to Vicksburg, have raised the rivers in the storm zone to the following critical stages, observed on Jan. 31: St. Louis, 31.2 ft., flood stage being 30 ft.; Cairo, 51.4 ft., flood stage 45 ft.; Memphis, 39.8 ft., flood stage 35 ft.; Vicksburg, 51.1 ft., flood stage 45 ft.; New Orleans, 17.8 ft., flood stage 18 ft. The Weather Bureau in commenting on this situation says: "While warnings already have been distributed to the points involved, it now seems probable that by reason of the continued rains the stages already forecasted will be exceeded slightly at various points and that high stages in the Mississippi from Cairo to the Gulf will be long continued." The West Hickman (Ky.) levee was penetrated by the Mississippi flood early on Jan. 31, resulting in the inundation of a large area in the manufacturing district. The report states that the water is backing up into the business section and that about 800 people have been made homeless. The failure of this levee is not an uncommon occurrence, owing to a sharp bend in the river at this point. Reports on Jan. 31 to the effect that the levee at Jacksonport, Ark., could not withstand the pressure of the flood waters more than a few hours more created anxiety in that locality. Trains on the Iron Mountain division of the Rock Island lines were detoured at Cypress Bayou, where the water had risen above the level of the tracks.

PERSONALS

Mr. Herschel M. Day, of Washington, Penn., has been elected Borough Engineer of Canonsburg, Penn.

Mr. John M. Egan, general manager for the receivers of the Metropolitan street Railway Co., of Kansas City, Mo., has announced his resignation, to take effect Feb. 11.

Mr. J. Lampton, recently Superintendent of the Gas Department of the Meridian (Miss.) Light and Power Co., has been appointed Superintendent of the Gas Department of the Jackson (Miss.) Light and Traction Co.

Mr. Howard P. Quick, M. Am. Soc. M. E., formerly Mechanical Engineer of the Pearson Engineering Corporation, of New York City, has opened offices as a Consulting Engineer, at 165 Broadway. He will make a specialty of public-utility engineering.

Mr. William G. Muse, Civil and Mining Engineer, of West Newton, Penn., whose term of office as County Commissioner of Westmoreland County, Penn., expired on Jan. 3, has been elected Chief Road Engineer of Westmoreland County by the new Board of County Commissioners.

Mr. N. B. Rhoads, recently with the Southern Railway and Light Co., of Natchez, Miss., has been appointed Superintendent of the Jackson (Miss.) Light and Traction Co. Mr. Rhoads has had considerable experience in railway transportation in the South, and before going to Natchez he was connected with railway work in Key West, Fla., and Savannah, Ga.

Mr. Edward W. Cunningham, M. Am. Soc. C. E., for the past four years Assistant Building Inspector, Department of Public Safety of the City of Cleveland, Ohio, has been appointed Commissioner of Buildings in that city. Prior to his employment with the City of Cleveland, Mr. Cunningham was First Assistant Engineer of the Osborn Engineering Co.

Mr. Frank E. Weymouth, M. Am. Soc. C. E., recently Supervising Engineer of the United States Reclamation Service on the construction of the Arrowrock dam at Boise, Idaho, has been appointed Chief of Construction of the United States Reclamation Service, with headquarters at Denver, Colo. He succeeds Mr. Sydney B. Williamson, who has resigned to accept private employment. Mr. Weymouth has been in the service for about 13 years in construction an doperation fields.

Mr. Ray S. Blinn, for the past five years City Engineer of Mt. Vernon, Ohio, has been elected Manager of the Town of Westerville, Ohio, with a salary of $1,500 a year. Mr. Blinn graduated from Ohio State University in 1893 and for some years after graduation was in the service of the Illinois Central R.R. For three years he was Division Engineer of the company at Chicago. Later he was connected with the city engineering department of Columbus, Ohio, in charge of paving, but on account of ill health was obliged to give up his work there.

Mr. John E. Dixon, Assistant Manager of Sales of the American Locomotive Co., has been appointed Vice-President in Charge of Sales of the Lima Locomotive Corporation, with headquarters at 50 Church St., New York City. Mr. Dixon is a graduate of the University of Wisconsin in mechanical engineering. In 1900 he entered the shops of the Brooks Works, at Dunkirk, N. Y., and in 1905 was made a salesman, and later manager, of the Atlantic Equipment Co., a subsidiary of the American Locomotive Co. In 1907 he was appointed Assistant Manager of Sales of that company.

Mr. Frank S. Krug, City Engineer of Cincinnati, Ohio, has been appointed chief engineer of the proposed Cincinnati Rapid Transit and Interurban Ry. He entered the office of the county engineer of Hamilton County, Ohio, upon graduation in civil engineering from the Pennsylvania Military College in 1884, and in 1891 was appointed County Engineer, in which office he remained for 14 yr. For some years afterward Mr. Krug was Secretary and Chief Engineer of the Kirchner Construction Co., of Cincinnati, and in 1914 accepted the appointment of City Engineer of Cincinnati, succeeding Henry M. Waite.

Mr. Samuel W. Fleming, Jr., of Harrisburg, Penn., has become a member of the firm of Farley Gannett, Consulting Engineer, Telegraph Building, in that city. Mr. Fleming for the last few years has been engaged in making reports on, and investigations of, electrical properties in the East and the Middle West and on electric railways in New York and Maryland. He will devote himself to the electrical work of the firm, giving especial attention to the design and construction of electric properties for corporations and municipalities and to valuations for rate adjustments; while the operation of properties will also be undertaken for corporations and municipalities. Mr. Fleming graduated from Princeton University in 1906 and then studied engineering at Lehigh University, graduating from that institution in 1909 with the degree of mechanical engineer. For several years afterward he was identified with the Central Hudson Gas and Electric Co. as Power Engineer.

OBITUARY

E. D. Barrett, a civil engineer employed on the new Peekskill (N. Y.) aqueduct of the Catskill Water-Supply, was shot and killed a few days ago by an Italian gardener who lived in the vicinity. Mr. Barrett was 61 years of age.

William Guiler, President of the William Guiler Co., of New York City, died at his home there on Jan. 18, at 45 years of age. Mr. Guiler built the first railroad in Porto Rico and erected the two wireless towers at Santo Domingo for the Government. He was well known in South America, where for a number of years he executed large contracts for coffee and sugar machinery, railway supplies and bridge materials. He was born in Scotland, the son of Hugh Guiler, a prominent naval architect.

Albert H. Scherzer, President of the Scherzer Rolling-Lift Bridge Co., of Chicago, was killed, on Jan. 28, by falling down an elevator shaft in the Monadnock Block. He was born in Peru, Ill., in 1865, and graduated from the Technical School of Zurich, Switzerland, and the Union College of Law, in Chicago. He practiced law for some years, but on the death of his brother, William Scherzer, the inventor of the rolling-lift type of bascule bridge, he became President and active head of the bridge company.

ENGINEERING SOCIETIES

COMING MEETINGS

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 2-5. Annual meeting in Indianapolis. Asst. Secy., W. F. King, Indianapolis, Ind.

INDIANA ENGINEERING SOCIETY.
Feb. 3-5. Annual meeting in Indianapolis. Secy., Charles Brossmann, 1616 Merchants Bank Bldg., Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Feb. 4. Mid-winter meeting in Chicago. Secy., E. B. Burritt, 8 W. 40th St., New York City.

OREGON SOCIETY OF ENGINEERS.
Feb. 7. Annual meeting. Secy., H. M. Morse, Portland, Ore.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 8-9. Mid-winter meeting in New York City. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Feb. 9-11. Annual meeting in Columbus. Secy., John Laylin, Norwalk, Ohio.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY.
Feb. 10-12. Annual meeting at St. Paul. Secy., Geo. H. Herrold, St. Paul, Minn.

ILLUMINATING ENGINEERING SOCIETY.
Feb. 10-11. Mid-winter convention in New York City. Secy., A. S. Miller, 29 W. 39th St., New York City.

NINTH CHICAGO CEMENT SHOW.
Feb. 12-19. First Infantry Armory and Coliseum. Secy., R. F. Hall, 208 South La Salle St., Chicago, Ill.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 14-15. Annual meeting at New Haven. Secy., J. Frederick Jackson, Chamber of Commerce Bldg., New Haven, Conn.

BUILDING INSPECTORS' CONFERENCE.
Feb. 14-15. In Chicago. Secy., S. J. Williams, Madison, Wis.

AMERICAN CONCRETE INSTITUTE.
Feb. 14-17. Annual convention in Chicago. Secy., John M. Goodell, 1418 Walnut St., Philadelphia, Penn.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 14-17. Annual meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 15. Annual meeting in Toronto, Can. Secy., L. V. Rorke, Parliament Building, Toronto, Ont.

SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 15-18. At Chicago. Secy., J. P. Beck, 208 South La Salle St., Chicago, Ill.

IOWA ENGINEERING SOCIETY.
Feb. 16-18. Annual meeting at Des Moines. Secy., J. H. Dunlap, Iowa City, Iowa.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 16. Annual meeting in Boston. Secy., N. W. Gifford, 38 Central Sq., East Boston, Mass.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 17-18. Annual convention in Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

IDAHO SOCIETY OF ENGINEERS.
Feb. 21-23. Annual meeting in Burley. Secy., I. F. Shaffner, Boise, Idaho.

ARKANSAS ENGINEERING SOCIETY.
Feb. 22-23. Annual meeting at Helena. Secy., W. J. Parkes, Citizens Bank Building, Pine Bluff, Ark.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 22-25. Annual convention in Pittsburgh. Secy., E. L. Powers, 150 Nassau St., New York City.

The Utah Society of Engineers will hold its annual meeting in Salt Lake City on Apr. 21. The secretary is C. J. Ulrich, State Engineer's Office, Capitol Building, Salt Lake City.

The Association of Iron and Steel Electrical Engineers announces that the 1916 convention will be held in Chicago, Sept. 18 to 22. The secretary is W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

The Memphis Engineers' Club at the recent annual meeting elected the following officers: President, C. K. Chapin; vice-president, A. L. Dabney; secretary, C. C. Pashby; directors, J. H. Haylor and H. N. Howe. The club membership is now 40.

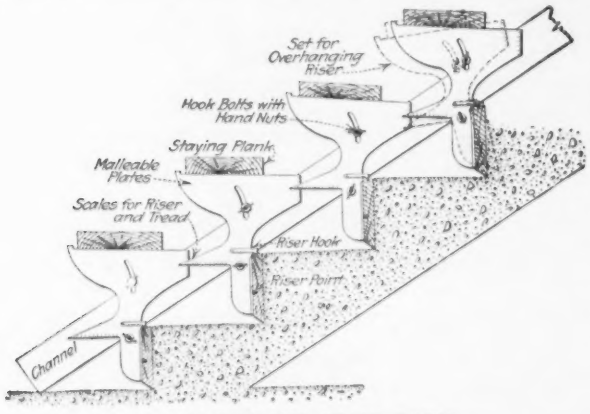
Engineers' Club of Atlantic City—Civil, electrical, mechanical, sanitary and hydraulic engineers and architects and structural contractors of Atlantic City, N. J., and vicinity have formed an engineers' club. This is said to be the first attempt to form such an association in this locality. Mr. J. Willis Gale, the secretary, states that the present outlook is for a large and energetic organization.

The Montana Institute of Municipal Engineers held the fourth annual meeting at Billings, Mont., Jan. 17 to 19. On the opening day two papers were presented: "Street Paving," by W. B. Vestal, Jr., and "Improvement District Laws." These were discussed by J. N. Edy, H. M. Sprague and E. S. Severance. On Tuesday morning Prof. Leon D. Conkling, of the Montana State College, delivered an illustrated address on "State Highways." Then there were moving-picture talks on "The Manufacture of Pipe," by a representative of the National Tube Co., and "The Concrete Farm," by a representative of the Red Devil Cement Co. In the afternoon Doctor Koyl, water expert for the Great Northern Ry., spoke on "Water Softening and Purification," while Mr. Davidson, of the Montana State College, delivered an address on "Standard Methods for Testing Sewage and Sewage Effluents." Papers were read by M. L. Morris, on "Parks and Playgrounds"; by State Horticulturist Dean, on "Preservation of Trees"; by G. C. Bruett, on "The Various Methods of Sewage Disposal, with Approximate Cost." These addresses were all well received and provoked much discussion, and this session was the strongest and most technical of the entire meeting. On Wednesday morning, F. C. Snow spoke on "Activated-Sludge Process of Sewage Treatment," while Chief Engineer Smith, of Burns & McDonnel, of Kansas City, gave an illustrated talk on "Water-Works Installations." In the afternoon the new filter plant of the Billings water-works was inspected. The officers elected for 1916 are as follows: President, Carl C. Widener, Bozeman, Mont.; vice-president, G. W. Helmick; secretary, John N. Edy; directors, M. L. Morris and F. C. Snow. The membership list now numbers 30 active, two honorary and two fellow members.

Appliances and Materials

Adjustable Step and Stair Form

A simple and novel concrete step and stair form has been devised by H. L. Park, of Reading, Mass., and is being sold by the H. L. Park Co., of that city. As shown by the accompanying sketch, the form consists of two steel channels supporting a suitable number of malleable-iron side plates which



PARK STEP AND STAIR FORM

carry the riser boards. The plates are held against the channel by hook bolts and hand nuts and are readily adjustable for height of riser and width of tread. Scales marked on the plates make these adjustments easy. A shoulder on the back side of the malleable plates keeps them in line on the channel. The riser boards are fastened to the plates by driving them on two steel points and clamping with top hooks. The plates can be adjusted for an overhanging riser. The upper part of the plates carries staging boards for workmen to go up and down. It has been found very easy with these forms to make steps that line up perfectly.

This form was developed first for long reinforced-concrete stairs, but it has been found equally satisfactory for short steps. For small contractors, short 2x4 joists are used in place of the steel channels. In service the channel or joist is first fastened at the top or bottom, the plates set and the riser boards put on.

* * *

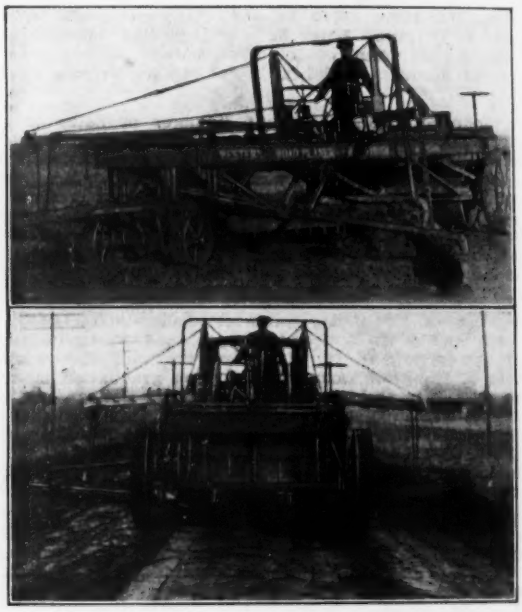
Trailer for Touring Cars

Under the name of "Troy Junior" a trailer wagon, designed particularly for use behind touring cars, has been developed by the Troy Wagon Works Co., Troy, Ohio. The track is 56 in. and the wheelbase 70 in. Wheels are of 36-in. diameter and have solid rubber tires, roller bearings and 1¼-in. square solid steel axles. The body is 35 in. wide, 96 in. long and 10 in. deep, with 6-in. side flare boards and drop gates at each end. The front springs are transverse semielliptic; the rear are full elliptic. A cushioned spring drawbar has its draft off the front axle and guides the front wheels in the track of the car. This trailer weighs 500 lb. and can carry 1,250 lb. The price is $125.

* * *

Road Planer and Finisher

A new road planer and finisher, designed to resurface, roll and finish the roadbed all in one operation, is shown in the accompanying views. The main frame is built of 10-in. I-beams. The wheels are 24-in. front and 48-in. rear, all with 8-in. tires. The tracking width of the front wheels is 5 ft. 2 in., and that of the rear wheels 8 ft. 9 in. The machine trims a 30-ft. width. Each blade, or scraper, is made in three 8-ft. sections, the rear sections on each side being fastened together. Each section of the blades is fitted with



WESTERN ROAD PLANER AND FINISHER

a detachable share like that of an ordinary road machine. Mold boards and shares are all interchangeable. There is a scarifier attachment between the blades, which is used as a supplementary leveling device. This is made of structural steel with tool-steel teeth and is drawn independently of the scraper blades and roller by direct connection to the kingbolt. It can be automatically set to cut to any desired depth. Between the rear wheels are six 42-in. rollers with a 12-in. face.

The control of the machine is as follows: The forward end of each blade is carried on a chain, going to a swinging drum attached to a crane arm. The chains are wound up by a worm gear and handwheel. The middle and rear blade sections are controlled by levers. These blades are for leveling and smoothing only, as the scarifier preceding them does the cutting. A supplementary leveling blade is hinged to the rear of the side blades to prevent leaving a sharp ridge at the center of the road. This device is controlled by a separate lever. The roller attachment is thrown in or out by self-locking worm gears operated by two handwheels, one on each side of the main frame.

It is claimed that this outfit can be used effectively for resurfacing hard roads as well as dirt and gravel. The machine is made by the Western Wheeled Scraper Co., Aurora, Ill.